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Engineering News-Record

Devoted to Civil Engineering and Contracting

An Issue Devoted Largely to Water-Works Subjects

Issued in connection with the annual meeting
of the New England Water Works Association

Covered Reservoir Combines Precast and Poured Concrete

Merits of Seven Kinds of Pumping Equipment Compared

Placing Gate Valves Under Water in a City Reservoir

Man-Hour Costs of Water-Main Trenching and Pipelaying

Features of Design of the Coolidge Multiple-Dome Dam

Plan of Water-Works Management at Madison, Wisconsin

Blowing Odors Out of Water of the St. Paul Supply

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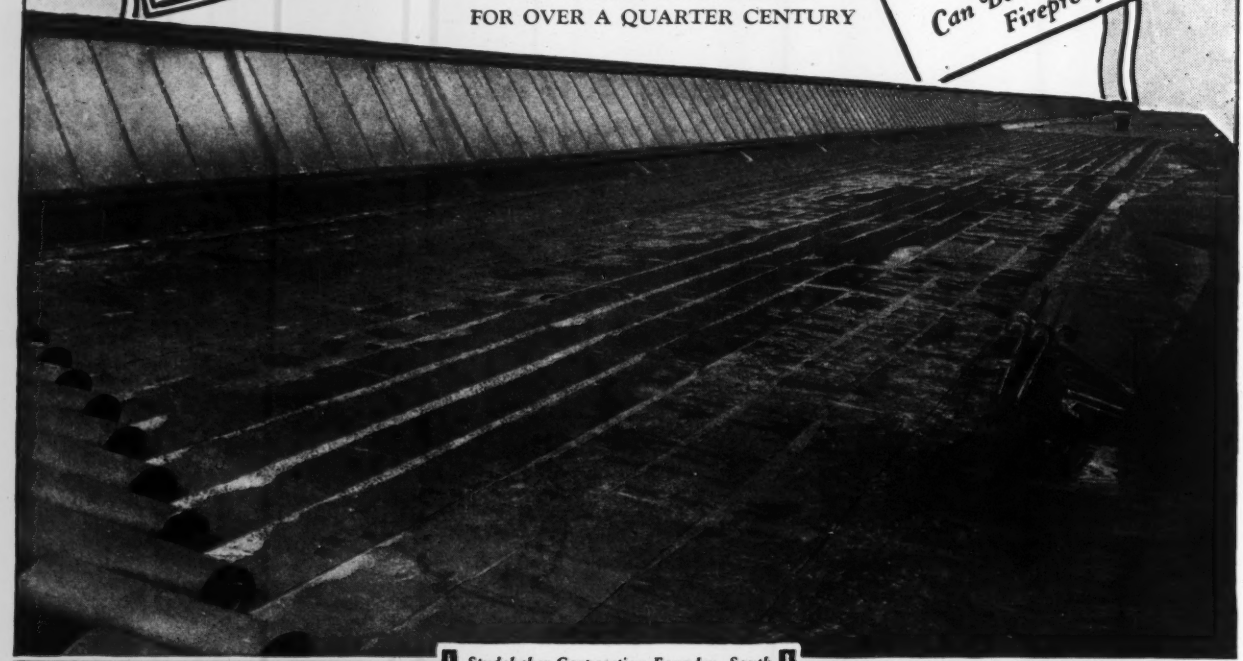

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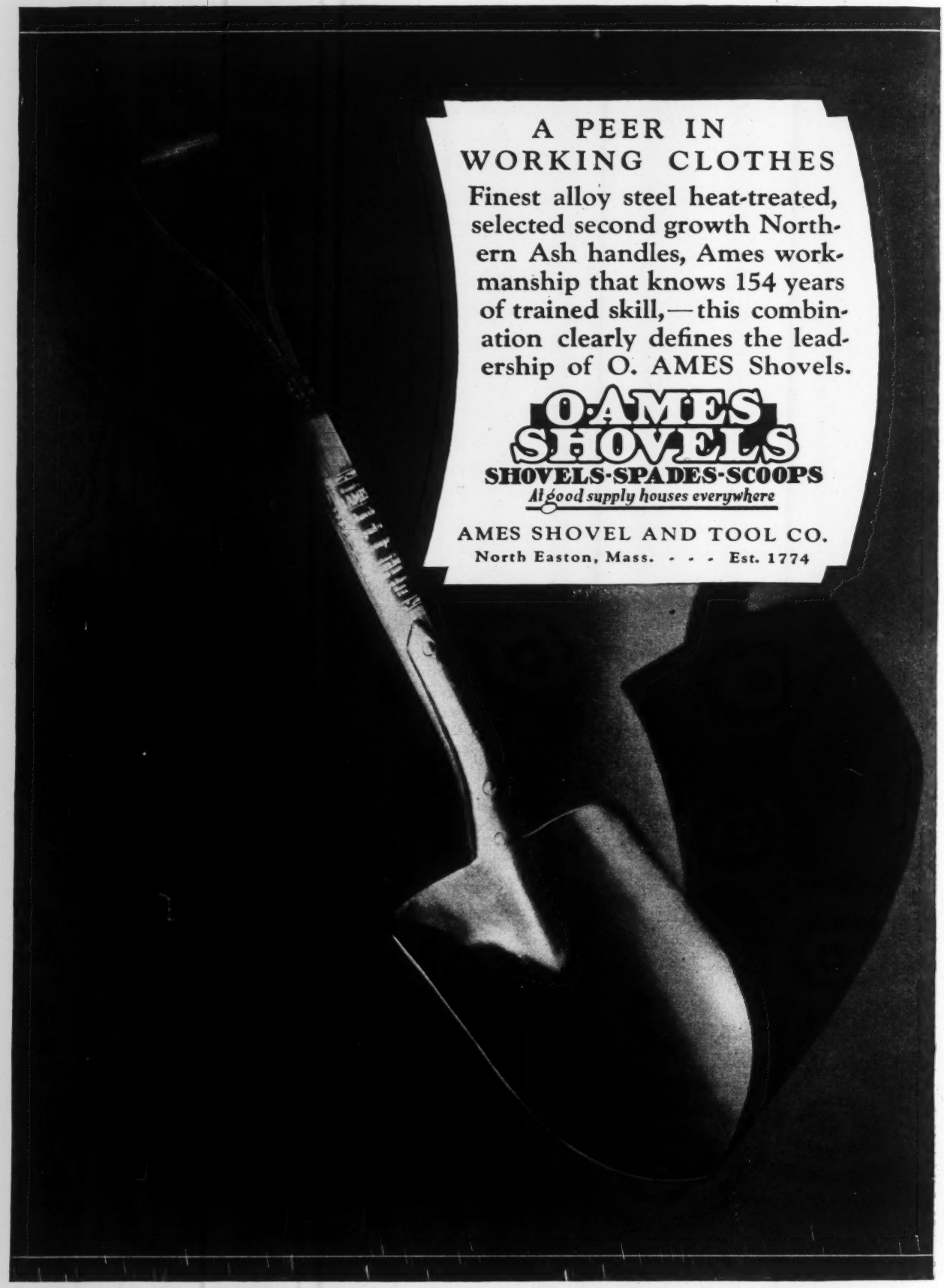
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Volume 101 NEW YORK, SEPTEMBER 13, 1928 Number 11

Pipelaying Costs

A LARGE element in the cost of any water-works system is pipe in place. Including the supply main from the source to the city, the pipe may account for a large percentage of the total cost, particularly where the supply is by gravity and there is no heavy outlay for impounding and distributing reservoirs. This makes data on the cost of such work of great value to the water-works engineer and superintendent. Unfortunately such figures, especially for recent years, are not plentiful. Highly welcome, therefore, are the data from the Baltimore County Metropolitan District presented in this issue. They are made more valuable by separation of costs of excavation and pipelaying, of hand and machine methods of moving the earth, and of costs for different trench depths. Man-hours make the figures independent of local wage or length of day—the latter not so important as formerly but still significant. Another valuable element in the data is the number of pounds of pipe laid per man-hour for the different diameters. Sizes of pipe range from 6 to only 20 in., but this comprises by far the greater part of pipe laid in distribution systems, as well as supply mains for the smaller cities. In view of the fact that on existing water-works many of the extensions made year by year are in relatively short lengths, the reporting of short-length jobs with moves between, and of single jobs of considerable length, adds to the value of an article which seems bound to be widely useful.

Choosing Pumps

HOW complex is the problem of choosing the pumping plant for even a relatively small water-works system finds an interesting illustration in some studies recently made in Illinois. Seven different types and combinations of plant were considered. Relative first and operating costs were by no means all the factors that had to be given weight. Back of these was state legislation on financing water-works improvements—peculiar to Illinois, we hope. After the possible types and combinations had been chosen and the cost analyses made, the choice was based largely on other considerations, including (1) the fact that the state legislation just mentioned made difficult if not impossible the continued use of existing buildings, and (2) the fact that the station is on the lake front, adjacent to a park and valuable residence property, making it desirable that the building should be small and that there be no coal and ash handling and no smokestack. These factors turned the balance to electric power with gasoline engine stand-by, rather than steam or combined steam and electric. The shrill hum of some of the types of pumping plant considered was also against their use at this site. Although some of these complexities were due to local conditions, the chances are that others would take their place elsewhere. Altogether, the article cited shows the need for competent enginering analysis and advice in the choice of a pumping plant for small as well as large water-works. Fortunate it is that the development of machinery has given us so wide a range of choice that all sorts of local conditions can be met, with the aid of an expert adviser interested no more in one than in another type or combination but only in helping the operator to choose that which will best meet all the needs at the lowest cost.

Not Their Business

"HIGHWAY safety is in large measure a moral problem," says the American Road Builders Association as the basis for an appeal to schools, churches and other institutions for aid in reducing traffic accidents. The statement implies an evasion on the part of the Road Builders of their self-assigned function in this world, which is to help in building roads well. If roadbuilding were perfect, and nothing further were required to make traffic safe than to improve traffic manners and train the individual to be more keensighted and more careful, the association might perhaps be excused for going outside its field and trying to enlist various foreign agencies in the work of traffic improvement. But this is not the case. The outstanding fact of the road traffic situation today is that physical hazards—as, for example, the multitude of dangerously narrow roads—make up the greatest element of traffic danger. It is the American Road Builders Association's business to study such matters, and this is the field in which, if anywhere, its membership can claim special competence. Trafficking in "moral problems" is not the association's business. And in addition it might be remarked that the statement that highway safety is a moral problem is essentially plain nonsense.

Safe Factors of Safety

AS WE understand it, one of the first principles of good design is that all determinable loads shall be definitely allowed for, while the intangible and undeterminable elements of service are covered by a marginal allowance, the well-known factor of safety. But some common practices violate this principle. An interesting case is that of basing building design on conventionalized wind-pressure values, even though far higher pressures are known to occur. Building practice in southern Florida, for example, is based on a 20-lb. wind pressure, although twice or three times as high pressures are experienced in the tropical hurricanes that visit these regions periodically. This practice is something like designing a crane for 10-ton capacity and using it for 25-ton loads—which is simply not done, at least with the designer's consent. A reform of practice in respect to Florida construction has been initiated by the Navy Department, which has recently put its structural designing on a basis of wind pressures estimated to be the equivalent of the most violent storms experienced there.

This is progress in the direction of making design figures represent actual facts. The navy's step is commendable, and it may be hoped that it will lead to a corresponding reform in general building practice.

Stability Through Regulation

A PROMINENT public utility leader declared in a recent public address that state regulation is responsible for much of the remarkable stability of utility securities at the present time. His statement emphasizes the notable achievement of governmental development within the past dozen or fifteen years. While the fact which he mentions has been recongnized by public utility men for some time, the present open avowal nevertheless invites attention, in view of the hostility which marked the relations between utilities and regulatory commissions not so many years ago. It is gratifying that constructive relations have taken the place of the former antagonisms, both as to the service and the necessary expansion of the utilities and as to the soundness of the great investments bound up in their plants and lines. Quite as significant is the change which has come to pass in the public's attitude toward utility problems, for the necessity of a close and continuing partnership between the consuming and the service-rendering interests is more widely appreciated today than once seemed possible. There is always a danger that these sound relations may be disturbed, however. Forces are nearly always active to render the best stability less secure, and recent developments indicate that utility men themselves are the point of origin of certain of these forces—for example, the disconcerting subterranean attempts at molding public sentiment on the part of some overzealous publicity men which were brought to notice in the Federal Trade Commission's inquiry a few weeks ago. The best promise of the future depends on eliminating these disturbing forces, in order that the utilities under wise regulation may sustain their stability and play their proper part in serving the growth of production, convenience and human comfort.

How Highways Help Farms

SEVEN years ago Maricopa County, in Arizona, attracted widespread attention by launching a $9,200,000 highway paving program comprising more than 300 miles of concrete road, built primarily to serve farm lands of the Salt River irrigation project. The roads were well built; they are still in excellent shape and show wear in very few places. The good condition is the more notable because this entire area is under irrigation and some of the pavement crosses land that much of the time is thoroughly soaked with drainage or seepage water. Stability under these conditions is doubtless aided by the fact that the thickened edges of this pavement (which became popular as the "Arizona type" when the Maricopa job was done; see *Engineering News-Record*, June 16, 1921, p. 1026) serve as inverted curbs and aid in retaining the subgrade in place. On the entire project, which comprises some 250,000 acres, there is now no farm house more than 1½ miles from a concrete road and for the most part trucks loaded with farm products move onto concrete pavement as they cross the farm property line. Other irrigation projects that study conditions in the Salt River Valley to see whether this road program was justified will find an affirmative answer. To begin with, of course, the project included good farm land and there was assurance of crops to haul. Having these prerequisites, it is almost a foregone conclusion that investment in good roads will be profitable. The people of the Salt River project are in closer touch with their friends and their community centers, they are happier and more contented, and the project as a whole, including the large city in its center, is far more prosperous than would have been possible without the far-seeing road policy adopted years ago. Without any disparagement of the great scenic highway projects that the United States has fostered in recent years or of the considerable attention that tourist travel receives from state highway organizations, it is refreshing to find an Arizona community, relatively small in point of population, able to take the lead in the extent to which its entire area is served by a network of paved roads built solely for hauling crops and making farm life happier. Its experience gives us proof that, within due limits of a proper regard for farm values, hard-surfaced roads are an excellent investment in any community where intensive farming is carried on.

Air-Transport Engineering

AT THE fall meeting of the American Society of Civil Engineers in San Diego, Calif., Oct. 3-5, the papers and discussion will center on airway and airport engineering. The subject is timely and the meeting place ideal. Although the United States has lagged behind Europe in the matter of commercial aviation, this country is now making rapid progress, as indicated by the fact that on Aug. 15 there were 367 municipal and 331 private airports in existence, with 754 additional airports proposed. The enormous increase in air mail on Aug. 1, following the reduced postal rates, is certain to cause added activity in all branches of air transportation.

The West coast, with its long distances between major centers of population, is ideal territory for efficient use of air transportation. Few cities are more air-minded, with definite ideas of what the air age will require when and if it arrives, than San Diego and its northern neighbor Los Angeles. San Diego has long been the scene of extensive naval air operations. Los Angeles is at the present time host to the finishers in the transcontinental air race and to the visitors to the largest aeronautical exposition yet held in this country.

Airport sites must be selected on the basis of engineering judgment and can be laid out to the best advantage only with the aid of engineering skill. Ideal soil conditions are not always available at points where landing fields must be located, which places a higher premium on ability to construct runways that will have a minimum of dust in dry weather or of soft spots when it is wet. Hangars without central roof columns are required; buildings, floodlighting systems and airway beacons are needed. In fact, laying out a landing field is, in many respects, like planning a small city. Nor is the need limited to a few large fields; the Los Angeles County Regional Planning Commission has recently published a map showing the location of 49 landing fields already established within that county, and a company was recently organized in California to build landing fields at 50-mile intervals along the Pacific Coast from the Mexican line to Canada.

Speedy development of aerial transport of this sort with the incidental need for landing fields, weather studies, etc., has created almost overnight a demand for technical men familiar with the principles of meteorology,

structural engineering, land drainage, roadbuilding and other sciences in which the civil engineer has been trained. In fact, no branch of engineering is nearly so well equipped to meet the general requirements as civil engineering with the broad foundation which it includes.

Naturally the civil engineer will do well to study all the requirements of the air-transport industry and be ready when there is opportunity to do his part toward the development of aerial transport within his own community. His present lack is published data on the subject. An interchange of views similar to that accorded other prime engineering subjects is absolutely necessary. The coming meeting of the American Society of Civil Engineers should do much to stimulate thinking and action along the right lines.

Cross-Connections

DOMINANT in importance and interest on the program of the convention of the New England Water Works Association at Montreal next week is the recommendation of the committee on cross-connections. Surprise, disappointment and uncertainty were exhibited when the committee reported to a luncheon meeting of the association a few months ago. It was evident that a more progressive report was expected and desired.

The disappointment arose chiefly from the weakness of the recommendations of the committee, compared with the strong resolutions for the elimination of cross-connections previously adopted by the American Water Works Association and the Conference of State Sanitary Engineers. The uncertainty related to the exact meaning of the recommendations, due in part to compromises between health protection on the one hand and fire and property protection on the other. The net result was that the report was referred back to the committee.

How extensive a revision the committee has made is not yet known. But it is sincerely to be hoped that the committee will take a stronger stand against cross-connections that it did last spring. The least that can be expected is that its recommendations for action by state and local authorities will be so clear that different interpretations cannot be put upon them by the parties of opposing interest.

If the committee's recommendations are sent to letter ballot, it is imperative to a determination of the real wishes of the members that the ballots be so framed that votes may be cast not merely for or against the committee's recommendation but on the fundamental question at issue—Shall health protection or fire and property protection be put first? A mere yes-or-no ballot on the recommendations made last spring might have left in doubt whether those voting thought the committee had gone too far or not far enough in its recommendations. If the revised report does not put the New England Water Works Association on all fours with the American Water Works Association and the State Sanitary Engineers against complete elimination of cross-connections, then both plans might be put on the ballot.

Although many would be sorely disappointed if the New England Water Works Association failed to join the other two associations and to support these cities and states which have declared that cross-connections must go, its members clearly have that right if they feel that way. But they should be afforded the fullest opportunity to record their opinion without a shadow of doubt as to the real meaning of their votes.

Economies in Composite Concrete Construction

POURED-IN-PLACE and precast concrete were combined in a highly profitable manner, it is asserted, in building the Stacy Park reservoir, described in this issue. This reservoir is one of several structures recently built where this procedure has been followed. In all of them the purpose has been to facilitate construction and not primarily to secure the structural advantage derived from the pretesting which comes from molding certain types of structural members in advance of their erection. The notable composite operations of the west-side sewage-works in Chicago and the complex Imhoff tank work at Flint, Mich., as well as the new St. Louis water-works reservoir now being considered, give scant indication that any superior structural advantage coming from precasting was a material factor in determining its adoption. In all the operations named precasting and pouring in place were combined to facilitate construction—to get more speed or a lower cost, or both of these advantages.

Precasting parts of a concrete structure is of material help to the builder in two particulars. It conserves time by enabling simultaneous performance of certain construction operations which normally succeed each other if the structure is altogether of poured concrete. It reduces and simplifies form construction and the equipment and labor for handling and placing concrete. The Stacy Park reservoir operation is fairly representative of practice and results.

In this St. Louis reservoir work, with 1,724 roof columns and 1,722 column braces to be molded, it was possible by precasting to produce them while the walls and floor, which had to be constructed first, were being concreted and to produce them largely in the intervals when the mixing plant was not called upon to provide concrete for walls and floor. It was possible also, in contrast with molding in place, to turn out the entire 3,446 units with little equipment, and that of the simplest sort, for carrying and placing concrete and fabricating reinforcement. In particular, form construction was reduced to a minimum. It was finally a simple traveling-crane operation to put up the roof-supporting structure virtually as fast as steel erection and, as in a steel structure, the concrete framework when in place was of ample strength to support roof forms and working operations on the reservoir top.

The sum of the savings in time and money due to the facts indicated is not available. In any event, of course, it could be only an estimate; but even such an approximation is not at hand. Admittedly there was a gain in speed and economy. This is the report also from the Chicago sewage-works operation and from the Imhoff tank construction at Flint, Mich. Indefinite as the information is, it forces consideration of a possible new set-up in concrete construction planning.

Obviously much concrete construction offers no opportunity for the composite method. Indeed, the Imhoff tank and covered reservoir construction described are, structurally, exceptionably favorable to its use. Without presenting equal inducement, however, there are still many similar types of construction that offer promising fields for combining precasting and pouring in place. The success so far experienced warrants consideration of its extension to these fields. The great need at present is something definite in estimates of savings.

Covered Reservoir Combines Precast and Poured Concrete

Columns and Braces Cast in Advance Cut Form Costs—Crane Erection Rapid and Rigid Connections Assured by Welding—Wet-Batch Hauling Cheapens Poured Work

By George D. Reichert
Resident Engineer, Stacy Park Reservoir, St. Louis, Mo.

An appreciable saving was made in constructing the Stacy Park covered reservoir for the St. Louis water-works by combining precast concrete with concrete poured in place. The contractor also obtained economy in handling materials by locating his mixing plant and casting yard at the railway 1½ miles away and hauling mixed concrete and precast columns and struts to the reservoir. Rounding out these main construction-plan features, the contractor installed an exceptional outfit of standard machines and special devices for moving earth and placing concrete and for handling forms and erecting the precast columns and braces. In the last operation unique use was made of welding in connecting the columns and column braces. All connections were made by welding together the projecting reinforcing bars and inclosing them in a fillet of poured concrete.

Reservoir Structure—The Stacy Park reservoir is a 100,000,000-gal. storage and service basin connecting the new water-works plant now being constructed at Howard Bend on the Missouri River and the present distribution system of the city of St. Louis. As shown by Figs. 1 and 2 and by the various views, the basin is a reinforced-concrete structure 806 ft. long and 603 ft. wide, having a reinforced-concrete floor and roof. The roof is a two-way continuous beam and slab structure supported by 1,724 precast concrete columns spaced 16½ ft. on centers and tied together in groups of fours by precast struts at about mid-height. The entire wall is surrounded by an earth backfill 22 ft. wide at the top and sloping 1 on 2½ to the original ground. The north, east and west walls are buttressed every 10⅓ ft. on the outside. These walls (Fig. 2) have at the top an integral concrete gutter to carry the runoff to a system of cast-iron pipes laid in the backfill. The south wall is designed as a division wall between the present basin (Fig. 1) and one to be built when the pumping plant at Howard Bend is fully developed. This wall has buttresses 10 ft. apart on both sides. There is no gutter on this wall, which rises 1 ft. in half the length of the basin to provide roof drainage. Set back 1 ft. from the toe of the wall foundations there is a cutoff wall of steel sheet piles from 9½ ft. to 18⅓ ft. long driven 6 in. into the hardpan which underlies the reservoir.

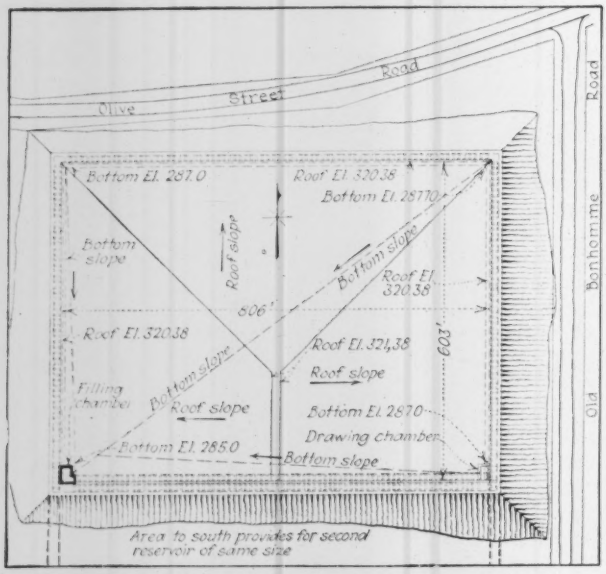

FIG. 1—DIAGRAM PLAN OF COVERED RESERVOIR, ST. LOUIS, MO.

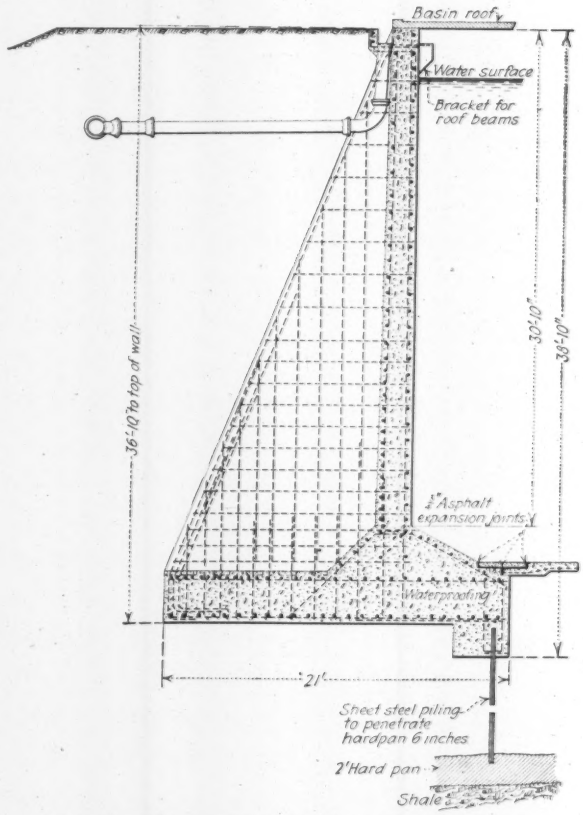

FIG. 2—WALL SECTION OF ST. LOUIS COVERED RESERVOIR

Location and Access—The reservoir site is 7 miles west of the city limits and 10 miles east of the Howard Bend pumping station. It was selected because there was ample space for a twin basin and because it was high enough to give a static head of 190 ft. at the connection with the city mains. The site also was between paved

roads on three sides (Fig. 3). It sloped southeast from a high point at about the middle of the north wall and had one draw to the west, one to the south and two to the east.

With its three adjacent paved roads the site was accessible at any season by motor vehicles. Also there was a railway line about 1½ miles east of the site. This was the natural route for getting in materials in the large volumes required. The problem of the contractor was how best to get them from the railway to the work, and it was solved by locating the mixing plant and casting yard at the railway and hauling by motor truck both mixed concrete and cast members to the job.

Mixing Plant and Casting Yard—The location selected was at Olivette, where land was available alongside the railway and fronting on Olive Street Road, which had concrete paving. A switch was built and the plant located as shown by Figs. 4 and 5. A 1-yd. tilting mixer operated by an electric motor was set in a concrete-lined pit 12 ft. below ground level. Over the mixer on a platform of 10x10-in. timbers and about 10 ft. above ground were five circular storage tanks with hopper bottoms; three of these tanks, of 500-bbl. capacity each, were for cement, one was for gravel and one was for sand. The sand and gravel bins each held 60 cu.yd.

Sand and gravel were unloaded from cars either into the bins or to stock piles by locomotive cranes. Cement was received in bulk in car lots and was unloaded with a power shovel, and elevated into the storage bins by a bucket elevator. The sand and gravel were measured into the mixer through a gaged hopper, and cement was weighed into the batches by bottom discharge buckets hung on dial scales and operating on an I-beam track arrangement. The mixer dumped into a bucket operating in a steel frame hoist which discharged into loading hoppers, under one of which trucks going to the reservoir were loaded and under the other of which concrete carts going to the casting yard were loaded. Figs. 4 and 5 show these two loading hoppers.

The casting yard calls for no other description than is

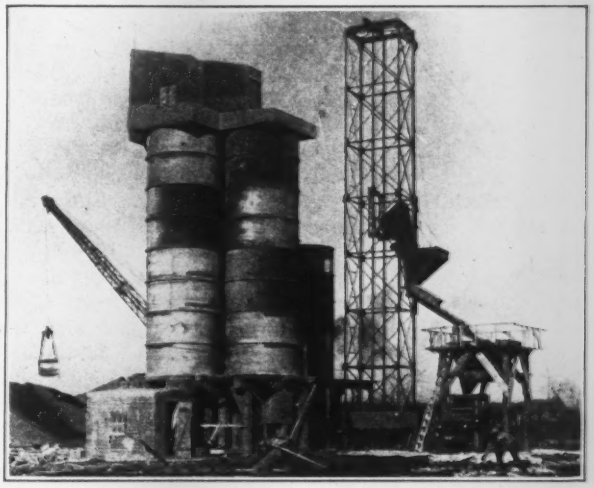

FIG. 4—CENTRAL MIXING PLANT AT RAILROAD SIDING

furnished by Fig. 5; the casting procedure is described later. The notable feature of the concrete plant is, however, not its arrangement or its equipment but its location at the railway 1½ miles from the job. By this location the use of bulk cement was possible, thereby cutting out the handling cost of cement in bags. Gravel and sand were for the most part unloaded directly from car to bins by a locomotive crane. While it would have been possible to haul dry materials to the job and there mix and place them using tower and chutes, it is believed that the procedure described worked out more economically.

General Plan of Construction—It was planned to build the walls first; excavating, driving sheet piles, setting reinforcements and placing concrete in order and as closely in succession as practicable. Then the floor excavation, using the earth to backfill the walls, floor concreting, column erection and roof construction were planned to proceed in succession inside the walls. Commonly several operations of the sequence were proceed-

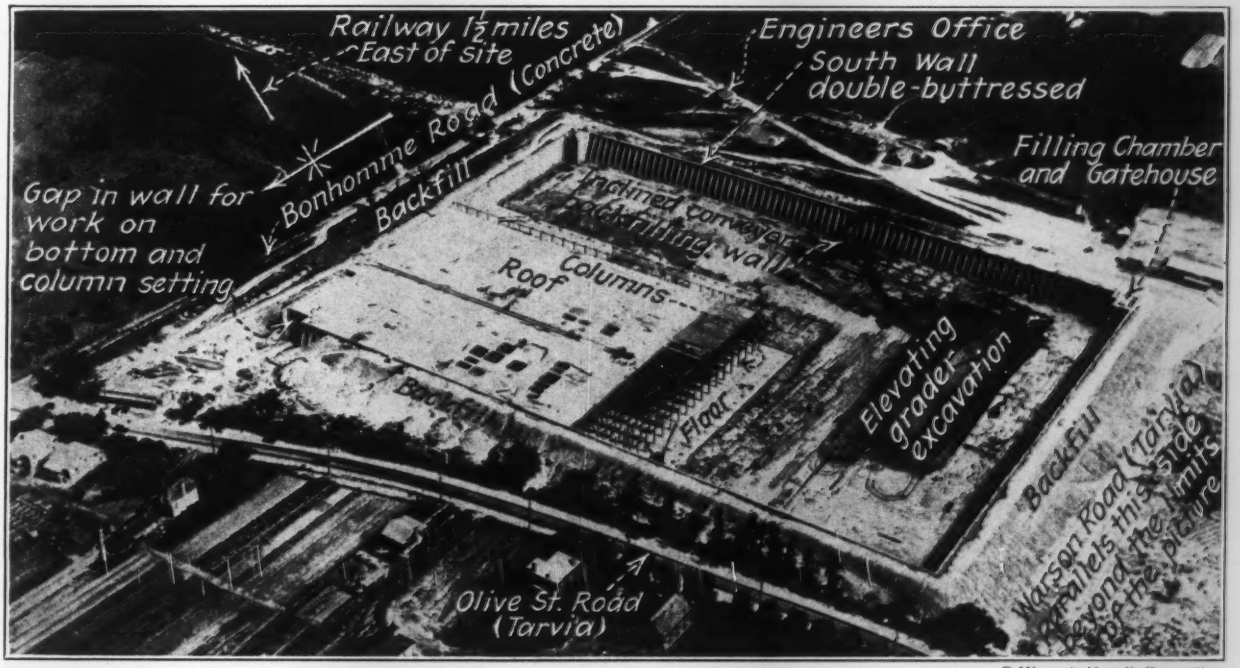

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FIG. 3—AIR VIEW OF LOCATION AND RESERVOIR STRUCTURE

ing at the same time and sometimes all of them were going on at once. The views indicate the close procession of operations. Therefore description in chronological order is not attempted but rather each group of like operations will be described independently.

Wall-Construction Methods—The trench for the wall footing and the narrower trench 2 ft. deeper (Fig. 6) for the sheet pile cutoff were dug by a gasoline crane operating drag and clamshell buckets. Ordinarily the material at subgrade level (El. 283.17, Fig. 2) was right for foundations, but where the walls crossed the draws previously mentioned the trench was carried down below subgrade elevation into good yellow clay and then refilled to subgrade level with lean concrete. The excavation was ordinary.

Nor was there any particular feature to the sheet-piling except that with a 2,760-ft. wall and four 90 deg. corners final closure was effected with regular piles. The driving was done with a double-acting hammer swung from the crane used for excavating. A horizontal boiler on skids was moved along with the driving to keep the steam line short. Driving was begun on Oct. 13, 1925, and finished on Aug. 9, 1926; in this period 45,950 sq.ft. of piling was driven. Fig. 6 shows a portion of the footing trench and the sheet-pile cutoff wall.

In concreting the walls the footing and the body were poured separately. Following the piledriving came the steel gang and close behind it the gang which concreted the footings as shown by Fig. 7. For bringing the mixed concrete to the work at the beginning, flat-bottom, steel-body, rear-dump trucks were used, but it was soon apparent that this type of body was not altogether suitable, as the concrete stuck to the sides and bottom of the body and segregated. In the spring of 1926 a new type of body was adopted. This was a hopper body built of wood and lined with sheet metal, discharging at the bottom. It gave excellent satisfaction (Fig. 8).

In pouring the footings the concrete trucks were run up on a movable platform or ramp (Fig. 7), in the deck of which was a hopper of sufficient size to contain a full batch and into which the trucks were unloaded. From this hopper the concrete was drawn through a hand-operated gate to a conveyor belt about 20 ft. long and rising on a slope of about 1 on 2 and was discharged into chutes for distribution to the forms.

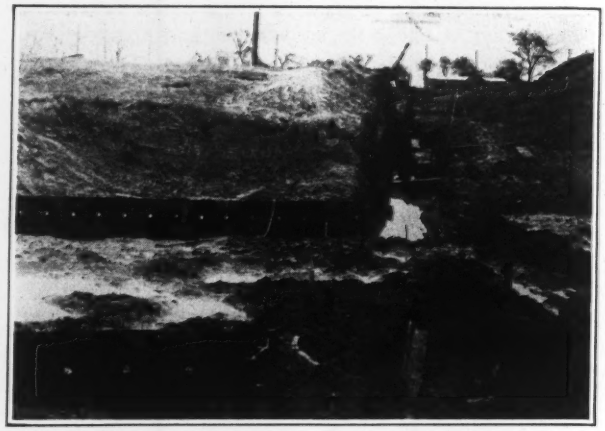

FIG. 6—FOOTING TRENCH AND SHEET-PILE CUTOFF WALLS

The ramp was mounted on wide steel-tired wheels and was moved on runway boards by a caterpillar tractor after first slightly raising the inclined approach. The conveyor, similarly constructed, was moved by hand. Power for operating the conveyor was supplied by a single-cylinder gasoline motor. This method of pouring footings was followed throughout and proved satisfactory in every respect, 10,800 cu.yd. of concrete being placed in this manner.

For pouring the walls a ramp (Fig. 8) quite similar to the one for footings was devised. This ramp, however, was larger, being mounted on double-flanged wheels and moved on 60-lb. T-rails on crossties by means of a dead man and cable operated by the niggerhead of a steam hoist mounted on the ramp itself. On the front side of

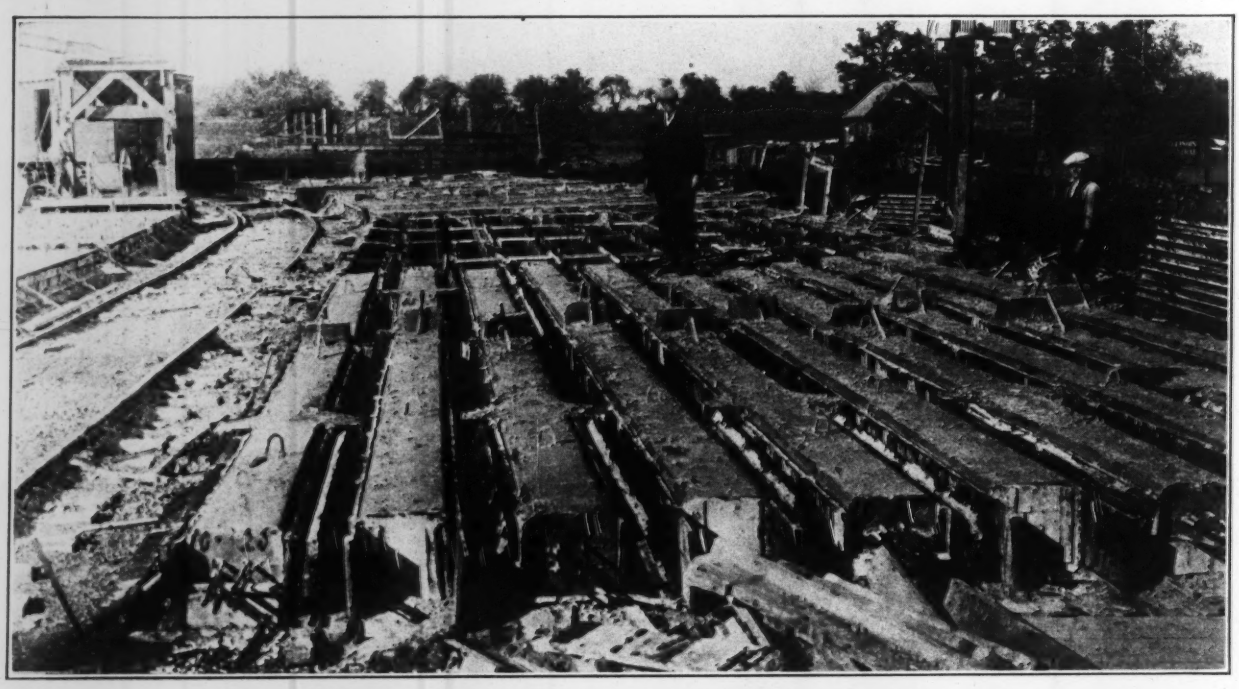

FIG. 5—COLUMN CASTING YARD AT CENTRAL MIXING PLANT

the ramp was a mast hoist with a ¾-cu.yd. self-opening bucket operated by the steam hoist. The lower 5-ft. section of the mast was hinged so it could be raised from the ground when moving. When in place for a pour this hinged section was let down and securely founded on the ground by wedges.

The forms for the walls were handled by a steel gantry rolling on 60-lb. rails. The rail on the inner side of the basin was laid on the concrete footing, which allowed 5 ft. clearance to the vertical face of the walls. The outside rail was laid on crossties about 30 in. outside the heel of the footing to provide clearance past the buttresses already poured. The vertical face form consisted of 2-in. lagging spiked to 4x6-in. uprights and tied in 16½-ft. sections by double 6-in. channels running transversely and spaced about 4½ ft. on centers.

with a trap door on rollers to permit passage for the mules. Bottom-dump wagons of 2-cu.yd. capacity drawn by three mules were used. These were loaded by an elevating grader drawn by a caterpillar tractor. From the hopper the earth passed to the belt conveyor beneath and was carried over the top of the wall to the backfill. The conveyor was operated by a 50-hp. gasoline engine mounted on the conveyor and the whole conveyor was mounted on eight wide-faced, steel-tired wheels, and was moved on runway planks, power being furnished by the tractor. This backfilling method was very successful; approximately 100,000 cu.yd. was handled (Fig. 9). The total excavation was 209,000 cu.yd. and the total backfill was 170,000 cu.yd.

Column Footings and Floor—When sufficient area of the bottom was down to subgrade, digging and concreting

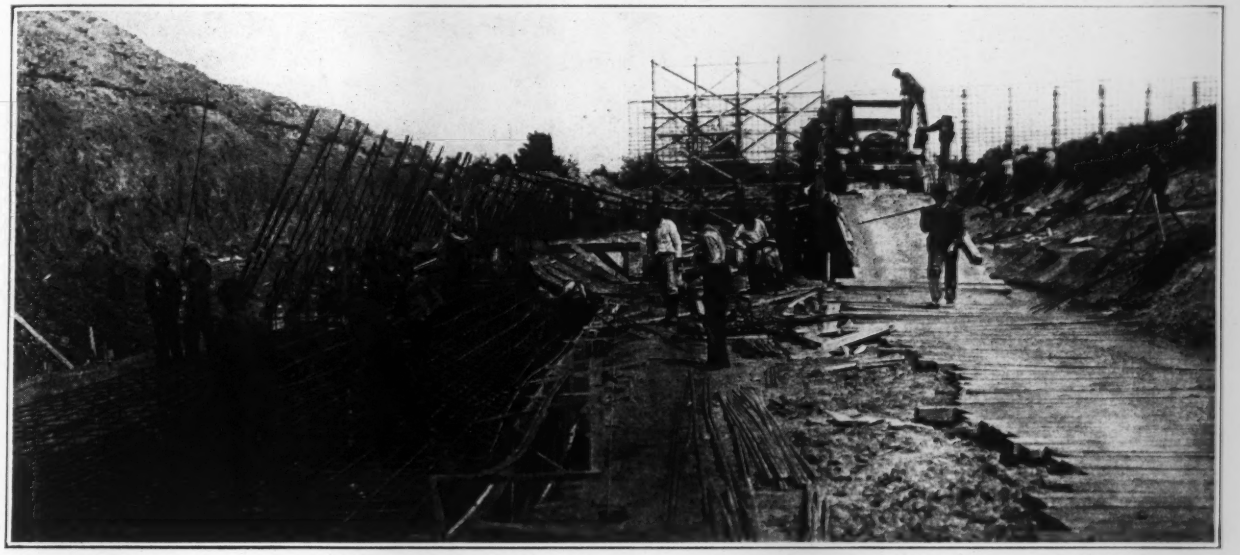

FIG. 7—CONSTRUCTION PLANT FOR WALL FOOTINGS

The forms for the buttressed side were built in much the same manner but were in three sections for each counterfort. All of the forms were handled from the gantry by means of chain blocks and turnbuckles for adjusting, leveling and aligning. To prevent spreading of the forms, truncated cones of cast iron with concentric threaded holes and spreader bolts were used. After a pour had been made and the forms removed these cones too were removed from the walls and the holes sealed with grout. The work on the wall superstructures began on April 26, 1926, and was completed on Sept. 23, 1926, except a 30-ft. section in the north wall (Fig. 3) which was left open to provide entrance to the basin for excavating, floor concreting and setting columns and struts. This opening was finally closed on Dec. 6, 1927. About 12,383 cu.yd. of concrete was handled.

Excavating Reservoir Bottom—Since the material in the reservoir bottom was to be used to backfill the walls (Figs. 1 and 3), the contractor was not able to proceed vigorously with excavation until a part of the walls was poured and sufficiently cured.

To make the backfill a 36-in. belt conveyor about 100 ft. long and rising about 1 on 3 was employed. The arrangement was such that the receiving end of the conveyor was under a movable ramp built on skids and provided with a receiving hopper which was covered over

the column footings were commenced. The footings are 3½x3½x3½ ft. with U-bar and hoop reinforcements. They are recessed 16x16 in. to various depths, the elevation of the column footings being controlled by the column length and the roof elevation. At each column footing the subgrade was dropped 4 in. over an area 5½x5½ ft.

The floor is a 6-in. reinforced-concrete slab with expansion joints and thorough waterproofing. It contains 9,800 cu.yd. of concrete and 633 squares of waterproofing. Concrete for the floor was brought into the basin in ¾-yd. trucks (Fig. 10) with side- and rear-dump hopper bodies. They were run in grooved tracks supported on low trestles over the reinforcing steel. Grade was maintained by means of screeds set in the subgrade. After striking off the concrete the screeds were removed and the surface was given a float finish.

Erecting Precast Columns—While the walls were being poured, the capacity of the mixing plant permitting, a force of men was engaged in precasting columns and struts at the central mixing plant.

The columns varied in length, by 6-in. steps, from 35 ft. to 37 ft.; also 46 columns of various odd lengths were required in the row adjacent to the division wall. A total of 1,724 columns was required. They were 14 in. square, with two sets of brackets on each column, one set being 17 ft. from the upper end on adjacent sides for the connecting struts, and the other set being 6 ft. from

the upper end and on opposite sides. This latter set of brackets was used by the contractor to support the roof forms, which are described later.

The columns and struts were poured in forms on the ground in a horizontal position. This permitted the use of one set of forms for all the columns and the 1,722 struts. After placing the fabricated steel reinforcing cages, runways supported on low trestles were placed over the forms and concrete was poured from two-wheeled carts. This arrangement permitted thorough shaking of the reinforcements and provided an entirely satisfactory set of columns and struts. After curing, the columns and struts were removed from forms by means of "pick-up loops" and a locomotive crane and then stored until needed (Fig. 5).

The columns were brought into the basin on specially built trucks, two columns and two struts constituting a load. They were unloaded and set with a caterpillar gasoline crane, then carefully plumbed with wedges and grouted in place.

As previously stated, the columns were tied together in groups of four by means of precast concrete struts. These rested on the lower set of brackets before mentioned, there being reinforcing rods projecting from the face of the columns above and below the strut brackets, which mated with similar bars projecting from the struts above and below near the ends. These rods were welded together with torches and the entire bond thus made was later inclosed in a concrete fillet.

Fig. 11 shows the column and brace arrangement. The main reason for adopting precast columns was the height of the columns. They were more than 30 ft. high and were braced in sets of four by horizontal cross-braces about half way between the floor and the roof. Formwork with such construction would have been very expensive.

As it was, the contractor installed forms for about twenty columns and an equal number of cross-braces on the same property with his central mixing plant and poured all his precast members in odd times when pouring the main structure was not in progress. Preparing the forms for precast columns consisted in knocking out a set of wedges, which loosened the side forms, picking up the column by a number of loops cast into the column and sweeping out and reoiling the forms.

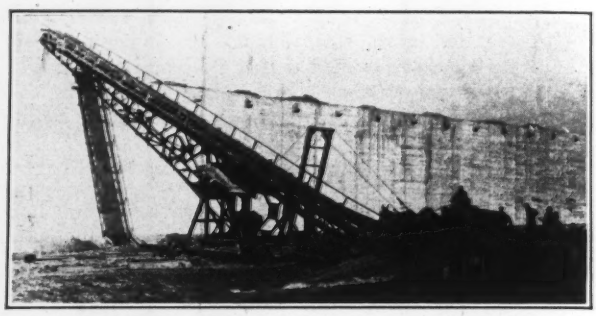

FIG. 9—BELT CONVEYOR BACKFILLING WALLS

The columns and struts were permitted to remain in the forms from four days to a week and were then piled in stock piles to be hauled to the job later by truck. Erection of these members proved quite easy. The columns were picked directly off the truck by a crane on a caterpillar mounting and set directly in the socket footing, which had been prepared some time in advance. The columns were plumbed and wedged in place with wooden wedges. Grout was then poured around the column in the socket footing while the column was held plumb by the wedges. The struts were put in place later and eventually a piece of reinforcing from the column was welded to a similar piece projecting from the strut and both pieces were incased in concrete.

While the cost figures are not available, there is no question that there was considerable saving over columns poured in place. The labor in erecting and stripping high column forms was entirely eliminated. The labor cost of precast columns is quite low after the initial fabrication of the forms.

Roof Construction—Steel forms were provided for the

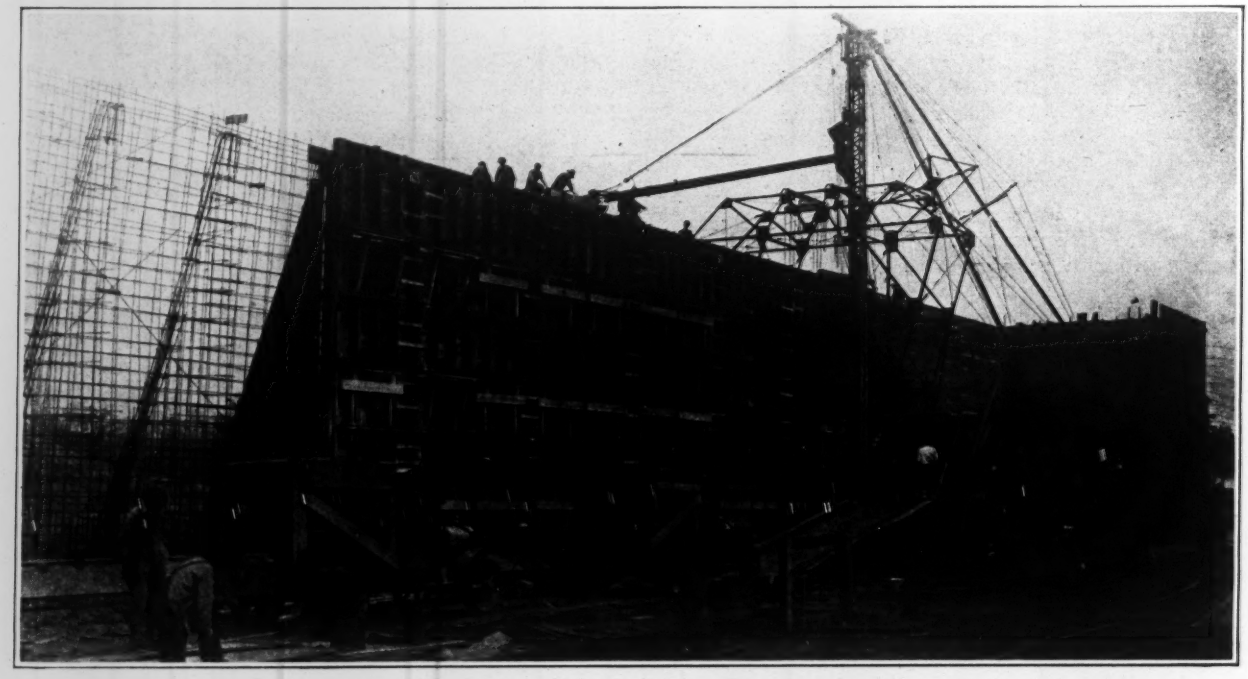

FIG. 8—CONSTRUCTION PLANT FOR WALL SUPERSTRUCTURE

FIG. 10—CONSTRUCTING COLUMN FOOTINGS AND FLOOR

roof and beams. These consisted essentially of structural steel side frames which were rolled along between the columns on the upper set of brackets to which were bolted cast-iron double-flanged dollies mounted in angle-iron frames.

The side frames or trusses were tied together transversely by channel irons, on which also were laid planks for the workmen. The upper section of the side frames was movable in a vertical direction and was operated by a set of eight screw jacks for each panel of forms. The forms were erected in place at the east end of the basin and extended from the north wall half-way across the width of the basin and including three spans of beams. A frame outrigger was built in the lead of the forms to carry the reinforcing steel for the panel ahead.

The forms for beams running east and west were so constructed that the sides could be loosened from the working platforms beneath and the soffits removed, permitting the form to pass the columns. The entire panel was let down by means of the jackscrews so as to clear the transverse beams, and the entire section was moved forward into new position with a tractor and winch and jacked into place again. Steel for the roof slab was fabricated into mats and placed in position while the beam steel was fabricated in place.

Concrete was hauled in the same type of trucks as for the floor. Unloading and placing were handled differently. A grooved runway built on ties and centering over a beam was constructed on the roof. This runway led to a movable ramp built on double-flanged wheels rolling on steel rails and centered over two columns. From this ramp the trucks were discharged into hand carts, which were wheeled onto the forms for distribution. By this system of forms it required sixteen moves from east to west and sixteen moves to return, with one move from the north half of the basin to the south half. This latter move presented a problem of considerable interest. To accomplish it three towers mounted on swivel dollies were built, providing a working platform about 28 ft. high. After removing the transverse members and staging from underneath the forms, these towers were rolled into place and the load of the slab forms was transferred from the side frames to the tower by means of jackscrews. When this work had been done the sides themselves were let down on cables passed through holes cored in the roof slab and operated by hand crabs.

The side frames were lowered into specially built trucks on casters and removed to the south half of the basin, where they were again erected in place with the caterpillar crane. Then the towers with the slab forms were rolled into place and the work of reassembling was concluded.

Concreting the roof began on Dec. 11, 1926, and was completed on Dec. 7, 1927, totaling 7,809 cu.yd. (Fig.10.)

Summary—The total quantities of materials and the prices paid to the contractor were as follows:

Concrete in walls and chambers	23,206 cu.yd.	$15.00
Concrete in columns, struts and column footings	6,974 cu.yd.	16.00
Concrete in roof and beams	7,809 cu.yd.	17.00
Concrete in floor	9,828 cu.yd.	9.00
Class B concrete	957 cu.yd.	12.00
Excavation	209,000 cu.yd.	.45
Reinforcing steel	5,490,000 lb.	.04
Steel sheet piling	45,950 sq.ft.	.40

The total amount of the contract will aggregate $1,220,000.

The work was handled under the general direction of John C. Pritchard, director of public utilities, and under the direct supervision of Leonard A. Day, water commissioner, E. E. Easterday, division engineer in charge of design, and George D. Reichert, resident engineer. The Frazier-Davis Construction Company, of St. Louis, executed the work, with F. R. Weiderholdt superintendent, ably assisted by Henry Snowden and Herman Bankus.

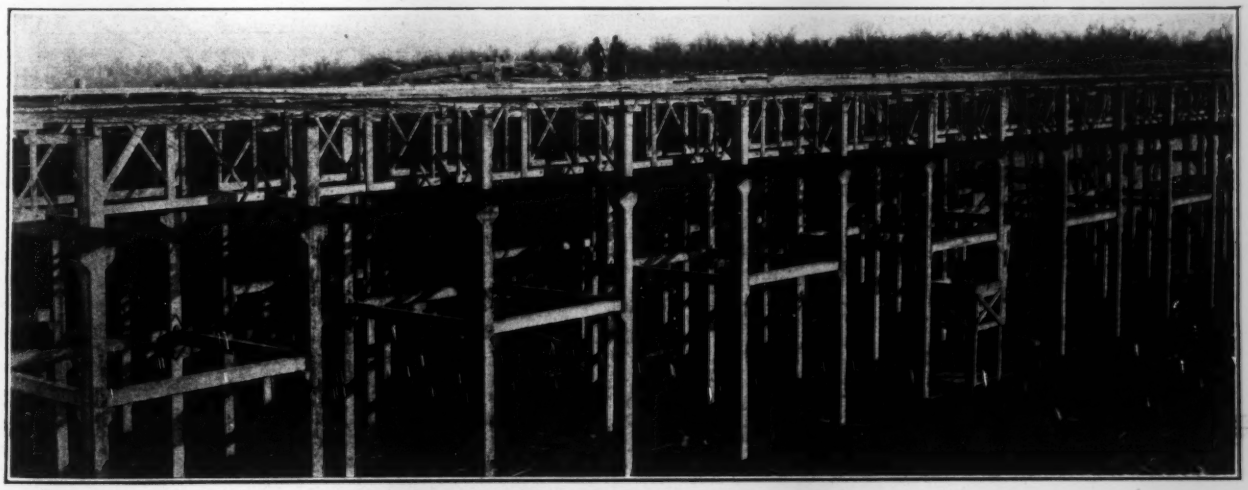

FIG. 11—ROOF FORMS CARRIED BY PRECAST COLUMNS

FIG. 8—CONSTRUCTION PLANT FOR WALL SUPERSTRUCTURE

The Merits of Seven Kinds of Pumping Equipment Compared

Study of Local Governing Conditions at Highland Park, Ill., Indicates Preference for Electrically Driven Centrifugal Pumps Using Purchased Energy

By Paul Hansen

Pearse, Greeley and Hansen, Consulting Engineers, Chicago, Ill.

SELECTION of type of pumping machinery often presents the most complex problem entering into water-works design in this day and age when so many types are available from which to choose. In connection with a new pumping station, filter plant and other water-works improvements at Highland Park, Ill., it became necessary to consider seven types or combinations of pumps: (1) High-duty reciprocating steam; (2) steam-turbine-driven centrifugal; (3) combination of steam-driven reciprocating and electrically driven centrifugal pumps using purchased electrical energy; (4) combination of steam-driven reciprocating pumps and oil-engine-driven centrifugal; (5) oil-engine-driven centrifugal; (6) oil-engine-driven generators with electrically driven centrifugal pumps; (7) electrically driven centrifugal pumps (using purchased electrical energy) with gasoline-engine stand-by units. Each of these types had apparent merit under local conditions. Before outlining the factors that entered into a comparison of their merits a background must be given of demands which the pumps must be ready to meet.

The works serve three towns—Highland Park, Highwood and Deerfield—all suburban in character. Future population is difficult to forecast and the best forecast that could be made after a careful consideration of all the evidence is given in Fig. 1.

Alternative methods of financing the proposed improvement were considered: The so-called water certificate plan and the revenue bond plan. The first is permitted under state legislation of 1899 and the latter under a new statute passed in 1927. Both laws permit financing water-works improvements by issuing securities which are not included in the bonded indebtedness of a municipality payable out of general taxation and which, under the Constitution, is limited to 5 per cent of the assessed valuation. Either water certificates or water revenue bonds constitute a mortgage on the works actually constructed from the proceeds of their sales. This peculiarity of both laws renders it impossible to incorporate existing structures into the works because they may not be mortgaged. The only way in which existing equipment can be used is to sell it and buy it back again. The water certificate law has a further limitation which prevents the enlargement or the improvement of the works until the issue has been retired. Under the newer law the securities can be refunded at any time and a new and larger issue may be authorized for the purpose of financing additions to the works.

When considering financing under the water certificate plan it therefore became desirable to provide for requirements up to the maturity of the issue, which was taken as 25 years hence, or in 1953. To avoid unnecessary immediate expenditure it was decided to build for the minimum anticipated population within the 25-year period—namely, 36,000—but to authorize an issue of water certificates that would permit the enlargement of the works within the 25-year period sufficiently to meet the probable maximum demand within that period—namely, the demand of a population of about 46,000.

Actually the water revenue bond method of financing was finally selected, which method does not require the authorization of an issue to meet the maximum demands anticipated prior to the maturity of the issue. Nevertheless, capacity to be provided at once and allowances for easily made future enlargements were determined in the manner required under the water certificate plan of financing, as outlined in the following paragraphs.

Average consumption will fall between 100 and 125 gal. per capita per day. Among the north shore suburban communities it is not the average consumption but the maximum day's consumption in the summer that determines the capacity of works, including pumps, because of the very heavy draft for watering lawns and golf courses. Fig. 2 shows, for typical north shore suburban communities, the relation between maximum daily per capita water consumption and population served. A figure of 280 gal. per capita per day was chosen as representing the

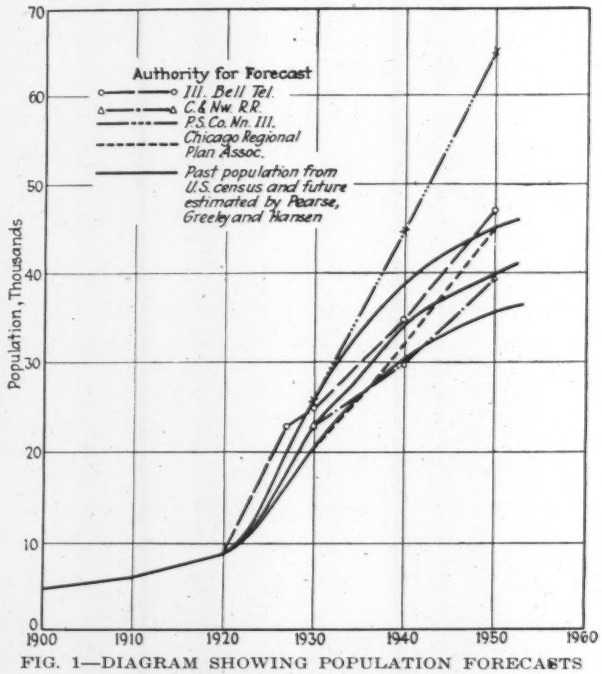

FIG. 1—DIAGRAM SHOWING POPULATION FORECASTS FOR HIGHLAND PARK, ILL.

The outer full lines show the limits within which future populations may fall. For purposes of computation a median

FIG. 11—ROOF FORMS CARRIED BY PRECAST COLUMNS

probable maximum day's consumption within the period for which works have been designed. On this basis there should be available about 10 m.g.d. for 36,000 people and about 13 m.g.d. for 46,000. As it is permissible for filter plants to operate about 40 per cent over capacity on days of maximum consumption, the capacity for immediate installation was taken at 7 m.g.d. and the additional capacity that might be required within 25 years at 3.5 m.g.d., making a total of 10.5 m.g.d. nominal capacity, or about 14.2 m.g.d. maximum, a somewhat greater quantity than may be needed. This, however, is on the safe side and is further made desirable because the exact estimated quantity does not readily conform to a convenient division into units. Storage of filtered water is provided in sufficient quantity to meet hourly fluctuations on a maximum day, thus permitting the filters to operate at a uniform rate. A part of this storage is on the distribution system, so the pumps will not be required to meet the maximum peak demand, but they nevertheless must have a wide range of delivery to meet with reasonable economy the variable rates of consumption, including consumption for fighting fires.

The combination of pumping equipment and principal accessories under each type of pumping station considered in making comparisons of the several types are presented in Table I. To explain why these combinations were selected in preference to many others that might have been used would increase the length of this article beyond reasonable bounds. Suffice it to say that while the combinations shown were not expected to represent the best combinations to be finally adopted, they fit local conditions, are comparable and the relative economies and merits would not be altered by using other permissible combinations. The combinations were also predicated on utilizing as much of the existing equipment as possible and explains the type using steam and electricity and the type using steam and oil engines.

Table I indicates principal items of pumping station equipment required in conjunction with a filter plant of 7-m.g. nominal daily capacity and also indicates units that must be added later when the filter plant is increased in capacity to 10.5 m.g.d. The low-lift pumps are shown for immediate installation only, as the same pumps may be made to serve for the enlarged plant. When the exact size of pumps does not materially influence economy, the word "graded" is used in the table to indicate pumps of suitably graded sizes.

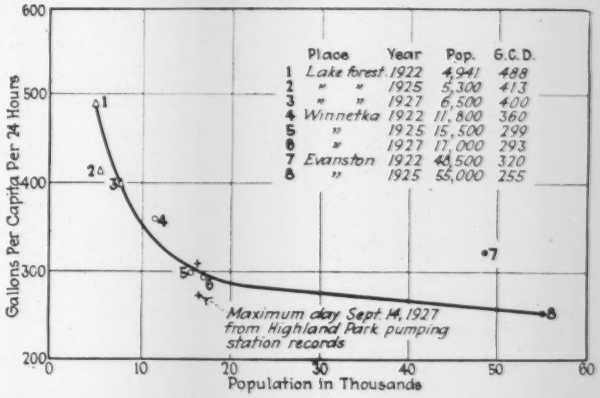

FIG. 2—MAXIMUM PER CAPITA PUMPING RATES FOR CHICAGO NORTH SHORE SUBURBAN COMMUNITIES

For each type of installation a suitable building arrangement was worked out as a basis for determining the installation cost. Types of installation using existing low-pressure boilers are assumed to require a relatively high grade of coal with natural draft as at present. Type No. 2, embodying complete steam turbine equipment, is set up on the basis of all new high-pressure boilers with superheaters operating under forced draft and using low-grade coal as a means of securing best economy. Electric energy charges are taken from published schedules of the Public Service Company of Northern Illinois.

No attempt will be made to discuss the more or less complicated processes of computation used in arriving at the cost of pumping water with the different types of pumping equipment. Suffice it to say they are substantially accurate and comparable. For the convenience of the city council the total annual costs of pumping with each type of equipment were reduced to cents per 100 cu.ft. of water pumped, which is the unit by which water is sold. The initial or installation costs, including filter plant and accessories, were also presented, as a choice may be largely influenced by this item. Table II presents these figures. The costs for 100 cu.ft. are given for different average populations that might prevail prior to the

TABLE I—PUMPING EQUIPMENT CONSIDERED UNDER VARIOUS TYPES

	(1) Steam High-Duty	(2) Steam Turbine	(3) Steam and Electric	(4) Steam and Oil	(5) Oil	(6) Oil-Electric	(7) Electric
Present installation—low-lift pumps	Steam turbine or engine 3 graded	Steam turbine or engine 3 graded	Electric 2 graded steam turbine or engine 1 7-m.g.d.	Steam turbine or engine 3 graded	Semi-Diesel 3 graded	Electric 2 graded semi-Diesel 1 7-m.g.d.	Electric 2 grade semi-Diesel 1 7-m.g.d.
Present installation—high-lift pumps	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. 1 6-m.g.d. 1 9-m.g.d.	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. Steam turbine 1 4.5-m.g.d. 1 10-m.g.d.	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. Electric 1 2-m.g.d. 1 4-m.g.d. 1 9-m.g.d.	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. Diesel 1 5-m.g.d. 1 10-m.g.d.	Gasoline 1 3-m.g.d. Diesel 1 2-m.g.d. 1 3-m.g.d. 1 5-m.g.d. 1 8-m.g.d.	Diesel Gen. 2 400-kva. Gasoline 1 3-m.g.d. Electric 1 1.8-m.g.d. 1 2.75-m.g.d. 1 3.75-m.g.d. 1 5-m.g.d. 1. 6.5-m.g.d.	Gasoline 1 3-g.m.d. Electric 1 1.8-m.g.d. 1 2.75-m.g.d. 1 3.75-m.g.d. 1 5-m.g.d. 1 6.5-m.g.d.
Future installation—high-lift pumps	High-duty steam turbine	Steam turbine 1 10-m.g.d. 1 3-m.g.d. Scrap 3-m.g.d. High-duty steam	Electric 1 11-m.g.d. Scrap 2-m.g.d. Electric	Diesel 1 10-m.g.d.	Diesel 1 9-m.g.d.	Diesel 1 300-kva. Electric 1 9-m.g.d.	Electric 1 9-m.g.d.
Wash-water pump	Hydraulic	Hydraulic	Electric	Hydraulic	Hydraulic	Hydraulic	Electric
Present installation boilers	*2 116-hp. †1 116-hp.	†3 125-hp.	*2 116-hp.	*2 116-hp.			
Future boilers	1 116-hp.	1 125-hp.					
Stack	New	New	Old	Old			

*Old. †New.

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When considering financing under the water certificate plan it therefore became desirable to provide for requirements up to the maturity of the issue, which was taken as 25 years hence, or in 1953. To avoid unnecessary immediate expenditure it was decided to build for the minimum anticipated population within the 25-year period—namely, 36,000—but to authorize an issue of water certificates that would permit the enlargement of the works within the 25-year period sufficiently to meet the probable maximum demand within that period—namely, the demand of a population of about 46,000.

Actually the water revenue bond method of financing was finally selected, which method does not require the authorization of an issue to meet the maximum demands anticipated prior to the maturity of the issue. Nevertheless, capacity to be provided at once and allowances for easily made future enlargements were determined in the manner required under the water certificate plan of financing, as outlined in the following paragraphs.

Average consumption will fall between 100 and 125 gal. per capita per day. Among the north shore suburban communities it is not the average consumption but the maximum day's consumption in the summer that determines the capacity of works, including pumps, because of the very heavy draft for watering lawns and golf courses. Fig. 2 shows, for typical north shore suburban communities, the relation between maximum daily per capita water consumption and population served. A figure of 280 gal. per capita per day was chosen as representing the

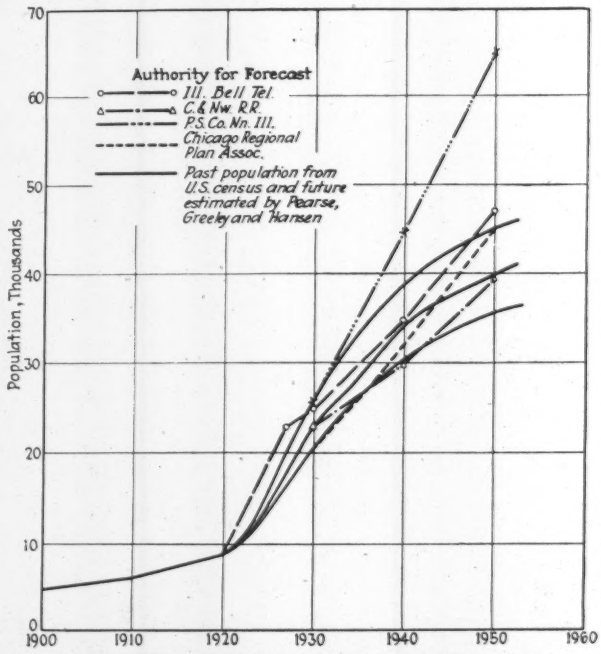


FIG. 1—DIAGRAM SHOWING POPULATION FORECASTS FOR HIGHLAND PARK, ILL.

The outer full lines show the limits within which future populations may fall. For purposes of computation a median line, as shown, was used.

probable maximum day's consumption within the period for which works have been designed. On this basis there should be available about 10 m.g.d. for 36,000 people and about 13 m.g.d. for 46,000. As it is permissible for filter plants to operate about 40 per cent over capacity on days of maximum consumption, the capacity for immediate installation was taken at 7 m.g.d. and the additional capacity that might be required within 25 years at 3.5 m.g.d., making a total of 10.5 m.g.d. nominal capacity, or about 14.2 m.g.d. maximum, a somewhat greater quantity than may be needed. This, however, is on the safe side and is further made desirable because the exact estimated quantity does not readily conform to a convenient division into units. Storage of filtered water is provided in sufficient quantity to meet hourly fluctuations on a maximum day, thus permitting the filters to operate at a uniform rate. A part of this storage is on the distribution system, so the pumps will not be required to meet the maximum peak demand, but they nevertheless must have a wide range of delivery to meet with reasonable economy the variable rates of consumption, including consumption for fighting fires.

The combination of pumping equipment and principal accessories under each type of pumping station considered in making comparisons of the several types are presented in Table I. To explain why these combinations were selected in preference to many others that might have been used would increase the length of this article beyond reasonable bounds. Suffice it to say that while the combinations shown were not expected to represent the best combinations to be finally adopted, they fit local conditions, are comparable and the relative economies and merits would not be altered by using other permissible combinations. The combinations were also predicated on utilizing as much of the existing equipment as possible and explains the type using steam and electricity and the type using steam and oil engines.

Table I indicates principal items of pumping station equipment required in conjunction with a filter plant of 7-m.g. nominal daily capacity and also indicates units that must be added later when the filter plant is increased in capacity to 10.5 m.g.d. The low-lift pumps are shown for immediate installation only, as the same pumps may be made to serve for the enlarged plant. When the exact size of pumps does not materially influence economy, the

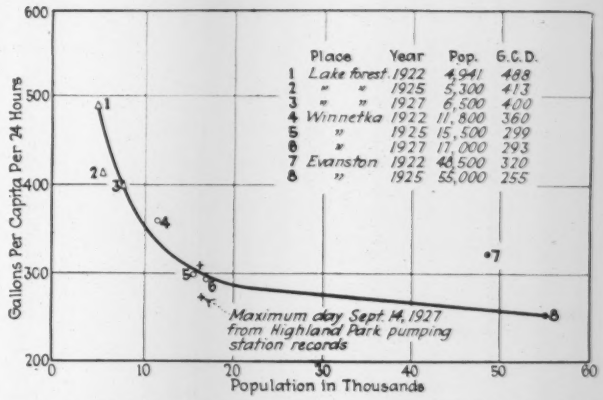


FIG. 2—MAXIMUM PER CAPITA PUMPING RATES FOR CHICAGO NORTH SHORE SUBURBAN COMMUNITIES

word "graded" is used in the table to indicate pumps of suitably graded sizes.

For each type of installation a suitable building arrangement was worked out as a basis for determining the installation cost. Types of installation using existing low-pressure boilers are assumed to require a relatively high grade of coal with natural draft as at present. Type No. 2, embodying complete steam turbine equipment, is set up on the basis of all new high-pressure boilers with superheaters operating under forced draft and using low-grade coal as a means of securing best economy. Electric energy charges are taken from published schedules of the Public Service Company of Northern Illinois.

No attempt will be made to discuss the more or less complicated processes of computation used in arriving at the cost of pumping water with the different types of pumping equipment. Suffice it to say they are substantially accurate and comparable. For the convenience of the city council the total annual costs of pumping with each type of equipment were reduced to cents per 100 cu.ft. of water pumped, which is the unit by which water is sold. The initial or installation costs, including filter plant and accessories, were also presented, as a choice may be largely influenced by this item. Table II presents these figures. The costs for 100 cu.ft. are given for different average populations that might prevail prior to the

TABLE I—PUMPING EQUIPMENT CONSIDERED UNDER VARIOUS TYPES

	(1) Steam High-Duty	(2) Steam Turbine	(3) Steam and Electric	(4) Steam and Oil	(5) Oil	(6) Oil-Electric	(7) Electric
Present installation—low-lift pumps	Steam turbine or engine 3 graded	Steam turbine or engine 3 graded	Electric 2 graded steam turbine or engine 1 7-m.g.d.	Steam turbine or engine 3 graded	Semi-Diesel 3 graded	Electric 2 graded semi-Diesel 1 7-m.g.d.	Electric 2 grade semi-Diesel 1 7-m.g.d.
Present installation—high-lift pumps	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. 1 6-m.g.d. 1 9-m.g.d.	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. Steam turbine 1 4.5-m.g.d. 1 10-m.g.d.	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. Electric 1 2-m.g.d. 1 4-m.g.d. 1 9-m.g.d.	Gasoline 1 3-m.g.d. High-duty steam 1 3-m.g.d. Diesel 1 5-m.g.d. 1 10-m.g.d.	Gasoline 1 3-m.g.d. Diesel 1 2-m.g.d. 1 3-m.g.d. 1 5-m.g.d. 1 8-m.g.d.	Diesel Gen. 2 400-kva. Gasoline 1 3-m.g.d. Electric 1 1.8-m.g.d. 1 2.75-m.g.d. 1 3.75-m.g.d. 1 5-m.g.d. 1. 6.5-m.g.d.	Gasoline 1 3-g.m.d. Electric 1 1.8-m.g.d. 1 2.75-m.g.d. 1 3.75-m.g.d. 1 5-m.g.d. 1 6.5-m.g.d.
Future installation—high-lift pumps	High-duty steam turbine	Steam turbine 1 10-m.g.d. 1 3-m.g.d. Scrap 3-m.g.d. High-duty steam	Electric 1 11-m.g.d. Scrap 2-m.g.d. Electric	Diesel 1 10-m.g.d.	Diesel 1 9-m.g.d.	Diesel 1 300-kva. Electric 1 9-m.g.d.	Electric 1 9-m.g.d.
Wash-water pump	Hydraulic	Hydraulic	Electric	Hydraulic	Hydraulic	Hydraulic	Electric
Present installation boilers	*2 116-hp. †1 116-hp.	†3 125-hp.	*2 116-hp.	*2 116-hp.			
Future boilers	1 116-hp.	1 125-hp.					
Stack	New	New	Old	Old			

*Old. †New.

TABLE II—SUMMARY OF COSTS FOR VARIOUS TYPES OF PUMPING EQUIPMENT

	(1) Steam High-Duty	(2) Steam Turbine	(3) Steam and Electric	(4) Steam and Oil	(5) Oil	(6) Oil Electric	(7) Electric
	Pumping Capacity, m.g.d.						
Total high-lift pump capacity	21.0	20.5	21.0	21.0	21.0	22.8	22.8
Capacity with one unit inoperative	12.0	10.5	12.0	11.0	13.0	10.0	16.3
Capacity with two units inoperative	6.0	6.0	8.0	6.0	8.0	3.0	11.3
	Cost Per 100 Cu.Ft. Delivered Into Mains, in Cents						
Average Daily Pumpage, m.g.d.							
2.0 (20,000 pop)*	5.90	5.65	5.63 to 6.15	5.62	6.08	6.18	5.80
3.2 (32,000 pop.)	5.62	5.38	5.12 to 5.55	5.41	5.84	5.92	5.45
4.0 (40,000 pop.)	5.36	5.10	4.92 to 5.35	5.12	5.53	5.52	5.21
4.0 (40,000 pop.)	7.00	6.44	6.02 to 6.40	6.57	7.01	6.96	6.28
First cost	$608,000	$565,000	$468,000	$535,000	$614,000	$620,000	$473,000
Second cost	292,000	237,000	188,000	257,000	262,000	246,000	187,000
Total issue	$900,000	$802,000	$656,000	$792,000	$876,000	$866,000	$660,000

*Population based on 100 gal. per capita per 24 hours.

maturity of the security issue. It is assumed, in order to keep the cost figures conservative, that the per capita consumption of water will be 100 gal. per day rather than a somewhat higher figure which will probably obtain. For a population of 40,000, the cost of pumping per 100 cu.ft. pumped is given for both the works to be immediately installed and the works to be ultimately installed to indicate the influence of additional fixed charges.

The combination steam and electrically driven pumps appear to have the lowest first cost and the lowest or nearly the lowest cost per 100 cu.ft. pumped. The low first cost is made possible by the continued use of practically all existing buildings and equipment. Observe that two sets of figures are presented for cost of pumping per 100 cu.ft. pumped. This is because the cost of pumping will be considerably affected by the care and intelligence the operator employs in balancing the use of electricity and steam. The lower figures are possible but not probable; the higher figures are probable.

The continued use of existing buildings is rendered difficult if not impossible by the methods of financing heretofore outlined, because the buildings cannot readily be sold and then bought back again. Furthermore, the retention of existing buildings renders difficult a convenient arrangement of the plant on the ground available and renders satisfactory architectural treatment of the buildings practically impossible. Still another objection to the maintenance of existing buildings and equipment is that this would require the continued handling of coal and the continued use of a tall chimney on the lake front adjacent to a public park and valuable residence property.

The steam-turbine type of equipment shows the next most favorable cost for pumping 100 cu.ft. of water, though for larger quantities and with increased fixed charges for the ultimate installation it presents somewhat higher costs than for the steam-electric type and for the all-electric type. Because the steam-turbine type requires complete new buildings and equipment, it permits suitable architectural treatment, but it still retains the objectionable coal handling and high chimney.

The next most favorable type from the point of view of cost per 100 cu.ft. pumped is the all-electric type, with moderate provision of gasoline engine stand-bys for emergency use. This type has practically the same installation cost as the combination steam-electric type and much more favorable installation cost than the steam-turbine type. Electrical equipment also has the advantage of not being dependent on skillful manipulation for maintaining operating efficiencies. Efficiency is primarily dependent on design and workmanship of the machinery. The original efficiencies, which can be ascertained and tested, can be maintained with regular oiling and ordinary attention, especially when pumping filtered water.

Needless to point out, electrical equipment does away with coal handling and an unsightly chimney and permits maximum latitude in architectural treatment. Moreover, it permits a neat, clean station of compact arrangement, simple to operate. The main drawback to operation with purchased electric energy is the possibility of power failure. At Highland Park underground connection may be had with four trunk transmission lines connected with two large generating stations to the north and to the entire Chicago system on the south, thus rendering shutdowns of more than a few minutes at a time very improbable. Provision to be made for elevated storage and the gasoline engine stand-bys will be ample protection against these occurrences.

None of the types involving oil engines has, under local conditions, any advantages in cost over the types already discussed. Nor have they any operating advantages. When not combined with steam, oil engines permit of satisfactory architectural treatment. On the other hand, they are noisy, especially when driving centrifugal pumps through high-speed gears, the shrill hum of which could be plainly heard in the adjoining park and bathing beaches. In this respect they are not inferior to turbine-driven centrifugal pumps.

In view of the predominating advantages of all-electrical equipment under local conditions, this type of equipment, with limited gasoline engine stand-bys, was chosen. It is not the purpose of this article to make a case in favor of electrical operation of pumping stations in general. On the contrary, it is recognized that any of the types of machinery considered might in certain localities and under conditions that are favorable constitute the most economical and desirable type. The advantages of high efficiencies over a wide range of pumping, smooth, quiet performance and long life of high-duty reciprocating pumps are not adequately reflected in the analysis here given. Were due credit given for long life, they would show net economies at least equal to if not better than any other types. High first cost, coal handling and chimney are against them in this case. Oil engines have a decided advantage where coal is expensive and where cheap reliable electric energy is not available. It is the purpose of this article merely to reflect the many considerations that enter into a sound decision.

Placing Gate Valves Under Water in Reservoir

Divers Set Frames for Valves Over Openings in Cross-Walls and Suction Pipes at Louisville, Ky.

By Charles B. Burdick
Alvord, Burdick and Howson, Engineers, Chicago

RECENT improvements at the Crescent Hill filter plant and pumping station of the Louisville Water Company, Louisville, Ky., have included alterations in the connections to the existing clear-water reservoir, to increase its usefulness and to make possible the temporary isolation of portions of it for future repair or alteration. It was necessary to do the greater part of this work under water, with the reservoir in service, under somewhat unusual conditions.

The Crescent Hill station (Fig. 1), completed about 25 years ago, includes a 27-m.g. clear-water reservoir, 363x436 ft. in plan, carrying about 23 ft. of water when full. This reservoir, of plain concrete, is built on a rock bottom. Its vertical sidewalls are approximately 14 ft. thick and the roof is of groined arch construction. Three cross-walls of plain concrete, 4 ft. thick, separate the reservoir into four divisions, although two archways through each wall, without means for closing them, prevent the isolation of these several compartments.

The old filter plant, with a later addition, is superimposed on the eastern compartment, while the pumping station adjoins the western side of the reservoir. Three 24-m.g.d. pumping engines were connected to one 60-in. header entering the reservoir by passing through a 72-in. cast-iron pipe embedded in the 14-ft. sidewall. This larger pipe terminated at about the middle of the wall and was belled out to 9 ft. in diameter at the inside face of the wall. A similar connection to a fourth pump, 40 m.g.d. in capacity, entered the reservoir through a similar bell-mouth.

Although these connections served the city satisfactorily for more than twenty years, the increasing pumpage made it desirable to alter them to permit the entire contents of the reservoir to be pumped if required in emergency. An addition to the filter plant, just completed on adjacent ground, also made it desirable for the new filters to be able to feed the pumps in an emergency, independently of the old reservoir, through a separate conduit with a small equalizing reservoir. This connection was needed also to provide for possible future repairs in the old clear-water reservoir and the original filter plant, if necessary. These connections involved alterations and connections to large water openings under conditions of continuous use. The Crescent Hill pumps supply the main part of Louisville under direct pressure, the rate of pumpage at this time ranging from 40 to 80 m.g.d.

In Fig. 1 are shown the 6-ft. conduit bringing water from the new filter plant and its connection to the 60-in. header supplying the original three 24-m.g.d. pumps. An extension of this header connects with a new suction well underneath an addition of the pumping station containing a new 40-m.g.d. turbo-centrifugal pump. This suction well also has a connection to the old reservoir, which

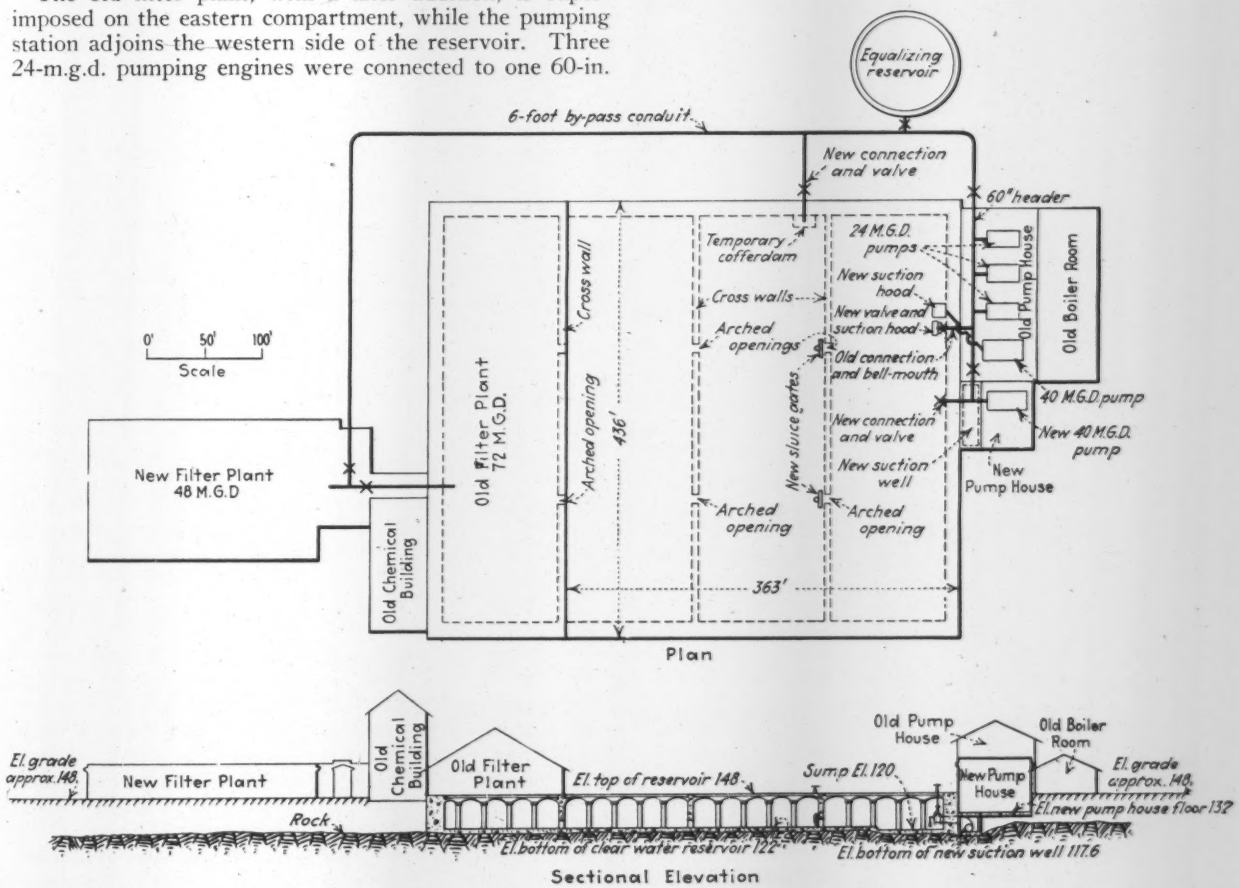


FIG. 1—OLD AND NEW CONNECTIONS IN RESERVOIR

had to be made in order to make these improvements complete.

In connection with the 6-ft. conduit, a valved connection was made into the clear-water reservoir at a point immediately east of the west cross-wall. This was done while the reservoir was in service by cutting through the 14-ft. concrete wall from the outside near the bottom of the reservoir and using a temporary cofferdam inside the reservoir in completing the connection through the wall, and grouting the connecting pipe in place.

As a preliminary to preparing the drawings for additional reservoir connections, an under-water survey was made with the aid of a diver to determine the exact dimensions of the cross-wall openings to be provided with gates and the condition of the concrete against which gate frames would be placed. These openings were 7 ft. 5½ in. wide and 8 ft. 1½ in. high. Drawings were then prepared for two 4x6-ft. sluice gates, with suitable frames, to close the arched openings in the first cross-wall east of the pumping station, as shown in Fig. 2. The gate frames were held against the gaskets on the face of the concrete by tie-rods extending through the openings and secured to two pairs of 8-in. I-beams on the opposite side. These sluice gates were placed by the aid of a diver operating through a hole in the roof

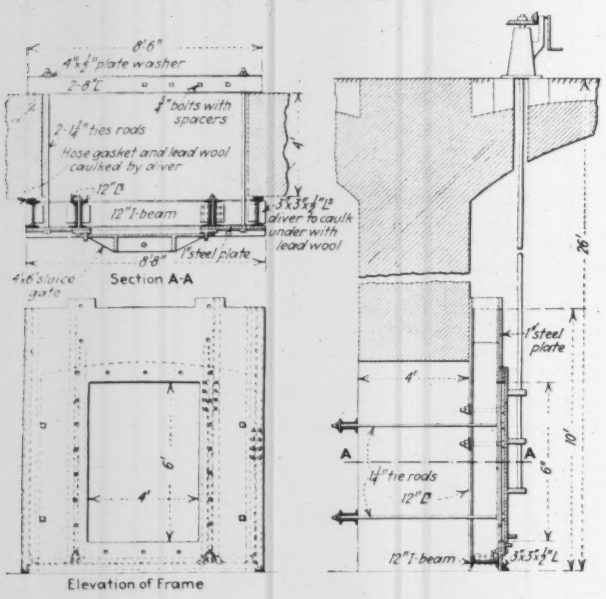


FIG. 2—VALVE TO CLOSE OPENING IN CROSS-WALL

immediately over each gate. With these gates closed, 10 ft. of water could be held in the eastern three compartments of the reservoir, the depth being limited by an overflow to a safe pressure upon the 4-ft. division walls.

To close the 9-ft. bell-mouth in the west side of the reservoir, communicating with the three 24-m.g.d. pumps, a rectangular steel frame was made carrying a flange to which a 6-ft. gate valve could be bolted. This construction is shown in Fig. 3. The frame, 10 ft. high and 11 ft. wide, lapped at least 6 in. over the edges of the bell-mouth. It was constructed of steel shapes, with a circular flanged thimble for bolting on the gate valve, and had radial steel ribs electrically welded to the structural members and the 1½-in. steel plate forming the back of the frame.

This frame was held against the wall by ten 10-ton screw jacks backed against two 14-in. vertical H-beams. These beams were grouted into 20-in. holes 8 ft. deep, drilled through the concrete and rock bottom of the reservoir, and were held at the top by anchor bolts passing through the side wall of the reservoir above the water line. A knee-brace at the bottom of each H-beam could be wedged rigidly in place and thus take a large part of the bottom strain if the grouting of the H-beam should be imperfect or if the rock should prove to be of inferior character. A gasket of collapsed fire hose was used between the gate frame and the wall to take up the slight irregularities in the concrete.

In placing this frame and the valve, the procedure involved the following operations in the order given:

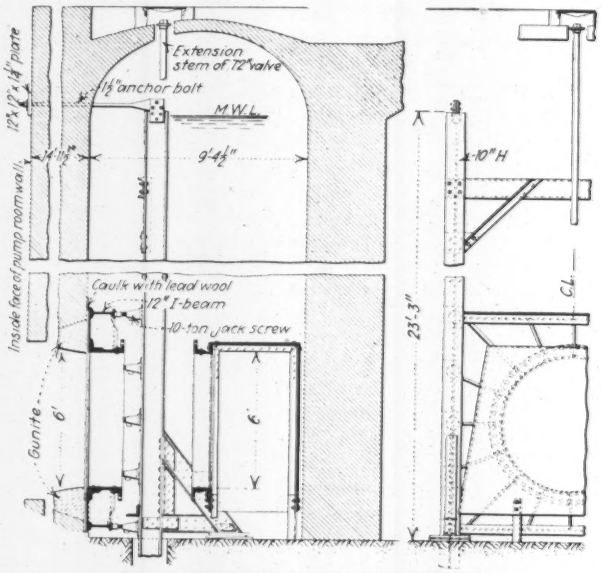


FIG. 3—NEW SUCTION CONNECTION

Setting and grouting the vertical H-beams, setting the gate frame, screwing up the jacks to force the gate frame snugly against the concrete wall, bolting on the 6-ft. double gate valve, and bolting a steel suction head to the flange of the valve. Although this work was done under water, all fits were successful. Upon completion, the leakage either in or out was found to be less than 5 g.p.m.

With this work completed, the 72-in. valve was closed, isolating the three 24-m.g.d. pumping engines, the city being supplied by the 40-m.g.d. pump, having an independent connection with the reservoir. The south end of the suction header in the pumping station was then connected to the 6-ft. conduit leading from the new filtration plant, and the north end of the suction header was connected to the new suction well. These operations were done on separate Sundays, when pumpage was at a minimum.

The entire clear-water reservoir was then pumped down to a depth of 10 ft. The cross-wall sluice gates were closed and the water in the west compartment of the reservoir was pumped down to a depth of about 1 ft. As the water neared the bottom, a valve on the 6-ft. bypass connection was gradually opened and the new 6-ft. gate in the reservoir wall was gradually closed, so that at the end of the operation the entire supply was delivered through the bypass. The remainder of the water was then pumped out, using a construction pump. With the west compartment of the reservoir dried, a reinforced-concrete suction hood was constructed over the opening supplying the 40-m.g.d. pump. A new connection also

was cut through the bottom and side of the reservoir, controlled by suitable valves, supplying a suction well to serve a new 40-m.g.d. turbo-centrifugal pump.

The difficulties of this work were increased by the heavy weight of the castings to be handled, the depth and relative inaccessibility of several of the connections and the importance of working to a time schedule on each individual job in order to insure the continuity of the water supply. When the work was completed, it was practicable, by closing certain valves and gates, to make the additional water-pipe connections required in the pumping station without interfering with the usual routine of operations. It is also possible to extend the plant in the future without in any way endangering the continuity of the water supply.

The work at Louisville comes under the direct charge of John Chambers, chief engineer and superintendent of the Louisville Water Company. W. Mac N. Gilchrist is resident engineer for Alvord, Burdick & Howson, consulting engineers, Chicago. The diving was done by G. W. Falcon.

New Haven's Water Supply to Be Increased by 45 M.G.D.

First Development Provides for 15,800-M.G. Storage Furnishing 15 M.G.D.—Rights Acquired for Additional Supply

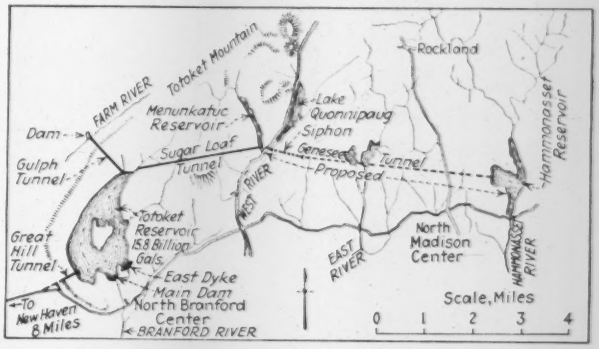
DEVELOPMENT by the New Haven Water Company of 53 square miles of watershed in the long-inhabited low hills of southern Connecticut will add 45 m.g.d., delivered by gravity to the present supply of 27 m.g.d. Work now under way in the North Branford district, east of the city, covers a drainage area of 18 square miles and will supply 15 m.g.d. Rights have been acquired for the future development of 35 square miles of watershed east of the North Branford district which will furnish an additional 30 m.g.d.

The North Branford development, as seen from the accompanying map, consists of the Totoket reservoir, impounding 15,800 m.g., covering 1,200 acres; two inlet tunnels, the Sugar Loaf tunnel, 3 miles long, and the Gulph tunnel, 1 mile long, carrying the runoff of two separate watersheds into the reservoir; and a 3,000-ft. outlet tunnel, known as the Great Hill tunnel, leading from the reservoir and connecting with a pipe line to the city. The Great Hill tunnel has been completed, while the Sugar Loaf and Gulph bores are still under construction.

To form the Totoket reservoir there have been constructed a concrete gravity-section dam 1,200 ft. long with a maximum height of 120 ft., and an earth dike 1,700 ft. long and 18 ft. high, with a concrete corewall. The dam contains an outlet which will be used only in an emergency or for the future supply of several small villages below the dam. The main outlet control works of the reservoir are located in a gatehouse at the intake of the Great Hill tunnel. A 48-in. cast-iron pipe line, 8 miles long, will connect the existing distribution system with the outlet tunnel. Construction of the pipe line has not yet been started.

The Gulph tunnel heads in Farm River and will carry its headwaters to the Totoket gravity system. Farm River now supplies water to one of the existing pumping systems. Ultimately the Sugar Loaf tunnel will be 8 miles long, tapping four streams, but at present the tunnel will terminate in the Menunkatuc reservoir, 3 miles from the Totoket portal. A concrete dam 250 ft. long and 60 ft. high will impound 350 m.g. in the Menunkatuc Valley, which has a drainage area of 4.3 square miles.

Ultimately the Sugar Loaf tunnel will be extended 5 miles eastward from the Menunkatuc portal to the proposed Hammonasset reservoir, which will have a capacity of 1,000 m.g. and will drain 26.7 square miles. The tunnel will cross two smaller streams, which also will be tapped. The entire tunnel system will be arranged to divert or pass the waters from any of the streams or reservoirs as required.



MAP OF NORTH BRANFORD DEVELOPMENT, NEW HAVEN WATER-SUPPLY SYSTEM

At present the water supply of New Haven is drawn from 98 square miles of watershed with a combined storage capacity of 3,333 m.g. About half of the supply (Woodbridge and Maltby systems) is by gravity. The other half is supplied by two 8-m.g.d. pumping plants in the Lake Whitney and Lake Saltonstall systems.

The North Branford development will be used mainly for storage purposes until the daily demand increases. With the total present storage capacity of only 3,333 m.g., an extremely dry season would cause a serious shortage.

In securing the water rights of the territory east of the North Branford district the water company believes that it has probably exhausted all the possibilities for surface supply in the New Haven sector of the state and has insured the city an ample supply for years. E. E. Minor, general manager of the New Haven Water Company, is in direct charge of the new developments. A. B. Hill, New Haven, is consulting engineer for the company, with C. M. Blair as engineer in charge.

Lavender and Peppermint From Sewage Farm

Lavender and peppermint are successfully raised on the sewage farm of the Sutton and Cheam Urban Council, England. According to London *Municipal Engineering* for Aug. 16, two acres of each crop were about ready for harvesting on the date named and had already been sold at a price of £25 ($122) per acre for the lavender and £45 ($219) per acre for the peppermint. The soil on this sewage farm is "London clay" and "has long been known as very suitable for" these two crops. According to our contemporary: "When areas are to be newly put under cultivation 'setts' are obtained from growing crops. . . . The cost of cultivation is quite small, little being required except weeding and hoeing over in late autumn. . . . No renewals are required for about eight years." Hedley Grieves is surveyor to the district council and Joseph Taylor is sewage-works manager.

Man-Hour Costs of Water-Main Trenching and Pipelaying

Based on Records of Work in Baltimore County, Md., in Last Seven Years on Short and Long Cast-Iron Pipe Extensions

By A. E. Walden and A. F. Di Domenico

Chief Engineer and Principal Assistant Engineer Water-Main Extensions, Respectively, Baltimore County Metropolitan District, Towson, Md.

The Scantiness of Data for estimating the cost of trenching and pipelaying for water-main extensions will make all the more welcome the summaries of seven years' work of the kind in Baltimore County, Maryland, given in the following article. The use of man-hours in place of dollars eliminates all questions as to the length of the laboring day. An apparent innovation is reporting the pipelaying in pounds per man-hour as well as in linear feet. Although limited to work done in 1928, the comparative costs of hauling to the job, jointing (including leadite and lead) and laying sand-cast and sand-spun pipe will be scanned with interest, as being among the very few data of the kind made public. —Editor.

While with the Baltimore County Water & Electric Company in 1921, records were kept in such manner as to show the number of feet of trench excavated per man-hour for both hand and machine work, as well as the pounds of pipe laid per man-hour by our various pipelaying gangs. This practice was continued when the Baltimore County Metropolitan District was formed in 1924. Data have been collected on the excavation of trenches and laying of approximately 730,000 ft. of 6- to 20-in. pipe. Until 1928 ordinary sand-cast iron pipe was used, but since then sand-spun iron pipe has also been used. Jointing material was entirely lead in 1921 and 1922; leadite with but few exceptions in 1924; while from 1925 to date leadite, with lead for every fifth joint, has been used. Except for pipelaying from 1921 to 1925 all work was done by contract.

Trenching—All excavation was divided into (1) miscellaneous-length contracts (in which jobs ranged from 60 to 2,800 ft. scattered about the district) and (2) section contracts (single jobs exceeding 3,000 ft. in length). We have made three distinct classifications of excavation—all hand work, all machine work, trenches dug by hand and backfilled by machine. These three classes are subdivided into standard depth, extra depth and jobs in which rock was encountered.

The following table shows the standard depth and width of various size trenches; also the linear feet of trench per cubic yard, it being the intent to have 3 ft. of cover in every case:

Size, In.	Depth, In.	Width, In.	Lin.Ft. Trench Per Cu.Yd.	Size, In.	Depth, In.	Width, In.	Lin.Ft. Trench Per Cu.Yd.
6	44	18	4.91	12	50	24	3.23
8	46	18	4.69	16	54	30	2.40
10	48	24	3.37	20	58	30	2.23

Under excavation no attempt has been made to keep the man-hours per foot for each year separately for each contract, as under the pipelaying tabulation, but all records are consolidated into miscellaneous contracts and section contracts during the four years 1924-28. This time includes hours digging test pits, locating ends of existing mains, digging bell holes, cutting macadam road surface, pumping wet trenches and tunneling, which is sometimes resorted to when crossing improved roads and is paid for as open cut. (See sketch for tunneling method used.) On four different crossings the following time was spent on tunneling, and represents about the average time usually required to make these crossings:

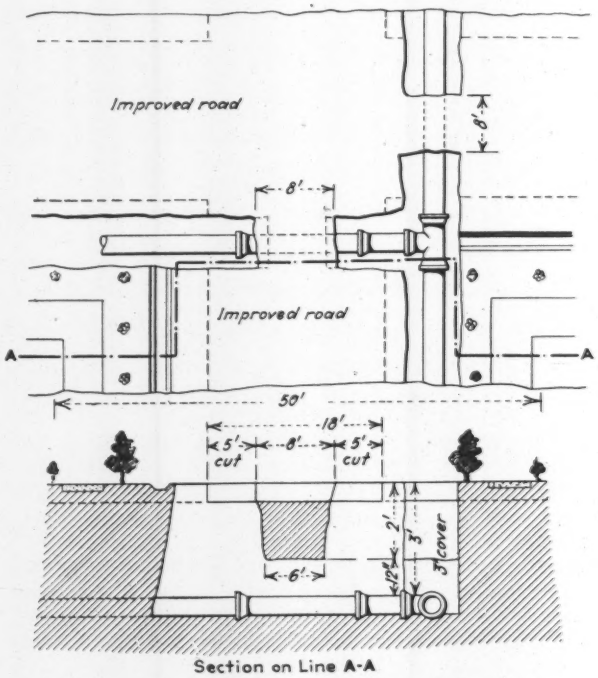
Depth, Ft.	Width, Ft.	Height, Ft.	Material	Labor, Hr.
20	2.5	3.5	Light gravel	9.0
9	2.5	3.5	Light loam	4.0
20	2.5	3.5	Tight gravel	14.5
18	2.5	4.0	Soft rock	8.0
67				35.5

Average, 0.53 man-hour per foot.

Under our specifications the following are the definitions of earth and of rock excavation:

Earth Excavation—Earth shall include any material that can be excavated with pick and shovel, ax or bar, or by machinery, including gravel, hardpan, sand of any kind, shells, clay, loam, macadam, conglomerate cemented gravel and sand, soft disintegrated rock, soft sand or rotten rock, foundations, loose stones or boulders ½ cu.yd. or less in volume, stumps or roots.

Rock Excavation—Any material shall be considered rock which, in the judgment of the engineer, cannot be excavated except by drilling and blasting, drilling and wedging, or



Section on Line A-A

METHOD OF TUNNELING UNDER IMPROVED ROADS

TABLE I—MAN-HOURS PER FOOT REQUIRED TO EXCAVATE TRENCHES UNDER MISCELLANEOUS CONTRACT

Summary of work done 1922-23 by Baltimore County Water & Electric Company and in 1924-28 by Baltimore Metropolitan District

A. All Hand Work

Size, In.	Standard Depth: No. of Jobs	Standard Depth: Feet Excavated	Standard Depth: Total Man-Hr.	Standard Depth: Man-Hr. Per Ft.—Max.	Standard Depth: Man-Hr. Per Ft.—Min.	Standard Depth: Man-Hr. Per Ft.—Av.	Jobs in Which Extra Depth Was Required: No. of Jobs	Jobs in Which Extra Depth Was Required: Feet Excavated—Total	Jobs in Which Extra Depth Was Required: Feet Excavated—Extra Depth	Jobs in Which Extra Depth Was Required: Feet Excavated—Per Cent Extra Depth	Jobs in Which Extra Depth Was Required: Total Hr.	Jobs in Which Extra Depth Was Required: Man-Hr. Per Ft.—Max.	Jobs in Which Extra Depth Was Required: Man-Hr. Per Ft.—Min.	Jobs in Which Extra Depth Was Required: Man-Hr. Per Ft.—Av.	Jobs on Which Rock Was Encountered: No. of Jobs	Jobs on Which Rock Was Encountered: Feet Excavated—Total	Jobs on Which Rock Was Encountered: Feet Excavated—Rock	Jobs on Which Rock Was Encountered: Feet Excavated—Per Cent Rock	Jobs on Which Rock Was Encountered: Total Hr.	Jobs on Which Rock Was Encountered: Man-Hr. Per Ft.—Max.	Jobs on Which Rock Was Encountered: Man-Hr. Per Ft.—Min.	Jobs on Which Rock Was Encountered: Man-Hr. Per Ft.—Av.	Total for Three Classifications: No. of Jobs	Total for Three Classifications: Total Feet Excavated	Total for Three Classifications: Total Man-Hr.	Total for Three Classifications: Man-Hr. Per Ft.
6	179	135,030	62,829	1.325	0.113	0.465	71	50,892	9,248	18.1	29,461	1.448	0.192	0.578	39	26,006	2,545	9.7	17,684	1.728	0.189	0.679	289	211,928	109,973	0.519
8	35	31,731	16,591	1.119	0.205	0.522	9	9,333	1,368	14.6	5,445	0.814	0.210	0.583	5	8,441	1,007	11.9	7,122	1.150	0.447	0.843	49	49,505	29,158	0.588
10	22	25,298	15,873	1.305	0.227	0.627	4	5,920	1,265	21.3	4,316	1.115	0.569	0.729	3	5,637	776	13.7	5,373	1.043	0.556	0.953	29	36,855	25,562	0.693
12	15	19,842	17,088	1.545	0.309	0.861	2	1,571	786	50.0	2,812	2.381	0.970	1.789	2	2,379	1,249	52.5	2,865	1.216	1.130	1.204	18	23,792	22,765	0.956
16	1	2,135	2,364	.....	.....	1.107	1	234	234	100.0	570	.....	.....	2.435	1	923	923	100.0	3,958	.....	.....	4.288	3	3,292	6,892	2.049
20	1	1,820	2,040	.....	.....	1.120	..	.....	.....	.....	.....	.....	.....	.....	1	601	400	66.0	1,166	.....	.....	1.94	2	2,421	3,206	1.324
B. Excavation of Trench by Hand, Backfill by Machinery																										
6	13	12,019	a3,605	0.409	0.241	0.300	8	7,088	1,307	18.4	e 2,745	0.408	0.322	0.387	1	1,492	50	3.3	h744	0.498	0.498	0.498	22	20,599	j7,094	0.344
8	3	5,532	b1,757	0.341	0.251	0.317	2	3,390	550	16.2	f 1,346	0.490	0.379	0.397	1	1,174	58	5.0	i544	0.463	0.463	0.463	6	10,096	k3,647	0.361
10	7	8,276	c2,776	0.521	0.259	0.335	..	.....	.....	.....	.....	.....	.....	.....	..	.....	.....	.....	.....	.....	.....	.....	7	8,276	l 2,776	0.335
12	1	4,605	d1,977	0.429	0.429	0.429	2	6,753	737	10.9	g 4,407	0.681	0.459	0.652	..	.....	.....	.....	.....	.....	.....	.....	3	11,358	m6,384	0.562

Backfilling: *a*, 120 hours; *b*, 70; *c*, 118; *d*, 61; *e*, 85; *f*, 45; *g*, 91; *h*, 20; *i*, 15; *j*, 225; *k*, 130; *l*, 118; *m*, 152.

heating and spalling with water. All foundations of concrete or of brick or stone, laid in cement mortar, will be classified as rock, if the volume requiring the removal at any single location is more than ½ cu.yd. This classification is not intended and shall not be intended to include materials which can be removed by means other than drilling and blasting, drilling and wedging, or heating and spalling, but which, for reasons of economy in excavating, the contractor prefers to remove by drilling and blasting.

No material, conglomerate cemented gravel and sand, soft or disintegrated rock which can be removed by pick or shovel, or boulders, or foundations less than ½ cu.yd. in volume, or loose shaken or previously blasted rock, or broken stone in rock filling or elsewhere, or rock exterior to the maximum limit of measurement which may have been loosened in previous excavation and which, by reason of such loosening, may fall into the trench will be measured or allowed for as rock.

Rock shall be stripped for measurement as directed by the engineer before excavating, and no rock excavated or loosened before measurement will be allowed or paid for as rock.

Rock excavation shall be divided into three classes as given below and paid for accordingly.

1. Rock that can be removed with pick, moil point and bar and exceeding ½ cu.yd. in volume. Foundations of concrete, brick or stone laid in cement mortar, or nested boulders in a conglomerate mass, having a volume of more than ½ cu.yd. in any single location.

2. Loose or seamy ledge or rock that can be broken down or wedged out with sledge, points or bar, or heating and spalling with water and occasional blasting.

3. Rock in solid masses in its original bed that must be blasted and that will ring when struck with a hammer.

In backfilling trenches after pipe is laid, one or more tampers to each shoveler, or equivalent when backfilled by machine, are required. The tamping is done with an iron hammer, weighing not less than 15 lb., or about ¾ lb. per square inch of contact area. Backfilling of trenches proceeds simultaneously with the laying of mains and as rapidly as mains are laid.

Table I shows the man-hours per linear foot required to excavate and backfill trench under miscellaneous contract, subdivided into jobs of standard depth, jobs in which extra depth was required and jobs in which rock was encountered, and also the summary of the three classifications. Part A of the table gives figures for all hand labor and Part B excavation by hand and backfill by machinery on miscellaneous contract. Table II shows the consolidation of standard depth, extra depth and rock trenches under (A) miscellaneous and (B) section contracts for both hand excavation and backfill and hand excavation and machine backfill and all machine work. The percentage of extra depth and rock excavation, of course, would be a great deal less if distributed over the entire number of feet instead of the feet and number of feet in which extra depth and rock was really encountered. In B no attempt was made to keep the time separate for the extra depths and rock in the section contracts, because where machines are used it is next to impossible to make other than an arbitrary allowance for the extra time.

When the work is done entirely by machine, the tabulated man-hours include the time of one backfiller operator, one trenching machine operator, one helper and all common labor. Common labor was used for digging bell holes, shoring, cleaning up, etc., and the number of laborers varied from two to seven per day, depending upon the rate of progress of the trenching machine. One man is required for the operation of the backfilling machine. The machine-hours represent the actual time that the backfiller and the trenching machine were in

TABLE II—SUMMARY OF STANDARD DEPTH, EXTRA DEPTH AND ROCK TRENCHES FOR HAND EXCAVATION AND HAND BACKFILL, HAND EXCAVATION AND MACHINE BACKFILL, AND ALL-MACHINE WORK

A. Under Miscellaneous Contract

Size, In.	Classification	No. of Jobs	Total Feet Excavated	Total Man-Hr.	Back Trencher-Hr.	Back Filler-Hr.	Extra Depth Ft.	Extra Depth Per Cent	Rock Ft.	Rock Per Cent	Man-Hours Min.	Man-Hours Max.	Man-Hours Av.
6	All hand work	289	211,928	109,973	...	...	9,248	4.4	2,545	1.2	0.113	1.728	0.59
	Hand exc. and mach. backfill	22	20,599	7,094	...	225	1,307	6.3	50	0.002	0.241	0.498	0.344
	All machine work	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	Total	...	232,527	.....	...	...	10,555	...	2,595	.....	.....	.....	.....
8	All hand work	49	49,505	29,158	...	...	1,368	2.7	1,007	2.0	0.210	1.150	0.588
	Hand exc. and mach. backfill	6	10,096	3,647	...	130	550	5.4	58	0.006	0.251	0.490	0.361
	All machine work	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	Total	...	59,601	.....	...	...	1,918	...	1,065	.....	.....	.....	.....
10	All hand work	29	36,855	25,562	...	...	1,265	3.4	776	2.1	0.227	1.305	0.693
	Hand exc. and mach. backfill	7	8,276	2,776	...	118	.....	...	.....	.....	0.259	0.521	0.335
	All machine work	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	Total	...	45,131	.....	...	...	1,265	...	776	.....	.....	.....	.....
12	All hand work	18	23,792	22,765	...	...	786	3.3	1,249	5.2	0.309	2.381	0.956
	Hand exc. and mach. backfill	3	11,358	6,384	...	152	737	6.5	.....	.....	0.429	0.681	0.562
	All machine work	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	Total	...	35,150	.....	...	...	1,523	...	1,249	.....	.....	.....	.....
16	All hand work	3	3,292	6,892	...	...	234	7.1	923	28.0	1.107	4.252	2.093
	Hand exc. and mach. backfill	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	All machine work	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	Total	...	3,292	.....	...	...	234	...	923	.....	.....	.....	.....
20	All hand work	2	2,421	3,206	...	...	.....	...	400	16.5	1.120	1.84	1.324
	Hand exc. and mach. backfill	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	All machine work	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	Total	...	2,421	.....	...	...	.....	...	.....	.....	.....	.....	.....

B. Under Section Contract

6	All hand work	4	16,791	5,626	...	...	436	2.6	.....	.....	0.113	0.470	0.335
	Hand exc. and mach. backfill	2	14,860	5,448	...	116	4,615	31.0	2,747	18.4	0.141	0.917	0.366
	All machine work	2	75,969	6,394	784	741	6,971	9.2	1,977	2.6	0.034	0.386	0.084
	Total	...	107,620	.....	...	...	12,022	...	4,724	.....	.....	.....	.....
8	All hand work	4	6,858	2,561	...	...	.....	...	.....	.....	0.356	0.386	0.373
	Hand exc. and mach. backfill	2	6,776	2,733	...	65	2,111	31.1	508	7.5	0.237	0.606	0.403
	All machine work	2	13,831	1,365	134	101	1,273	9.2	.....	.....	0.045	0.623	0.098
	Total	...	27,465	.....	...	...	3,384	...	508	.....	.....	.....	.....
10	All hand work	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	Hand exc. and mach. backfill	2	8,334	3,959	...	85	1,318	15.8	610	7.3	0.436	0.506	0.475
	All machine work	2	6,077	429	60	58	.....	...	.....	.....	0.061	0.154	0.070
	Total	...	14,411	.....	...	...	1,318	...	610	.....	.....	.....	.....
12	All hand work	4	20,438	13,854	...	...	3,289	16.1	1,535	7.5	0.506	0.845	0.677
	Hand exc. and mach. backfill	2	17,961	8,701	...	215	4,087	2.7	.....	.....	0.390	0.823	0.484
	All machine work	2	8,117	1,323	207	45	855	10.5	647	80	0.064	0.200	0.162
	Total	...	46,516	.....	...	...	8,231	...	2,182	.....	.....	.....	.....
16	All hand work	1	13,034	6,964	...	...	2,995	22.9	.....	.....	0.534	0.534	0.534
	Hand exc. and mach. backfill	2	18,324	12,747	...	214	5,468	29.8	560	3.05	0.491	1.132	0.695
	All machine work	1	2,133	793	65	20	.....	...	.....	.....	0.371	0.371	0.371
	Total	...	33,491	.....	...	...	8,463	...	560	.....	.....	.....	.....
20	All hand work	1	660	1,515	...	...	.....	...	.....	.....	.....	.....	2.295
	Hand exc. and mach. backfill	...	.....	.....	...	...	.....	...	.....	.....	.....	.....	.....
	All machine work	1	2,500	657	77	25	.....	...	.....	.....	.....	.....	0.262
	Total	...	3,160	.....	...	...	.....	...	.....	.....	.....	.....	.....

operation. No account is taken of the time the machines were standing idle.

Pipelaying—The pipelaying data include time laying pipe, placing fittings and valves and setting fire hydrants at an average distance of 1,000 ft. apart. It also includes time making connections to existing mains, but does not include truck-hours. We have found that truck-hours are 9 per cent of the total labor, or 8.3 per cent of the combined labor and truck-hours.

Approximately one-half of the pipe laid in the Baltimore County Metropolitan District was under the so-called miscellaneous short-length contract—that is, on jobs where the main extension is anywhere from 60 ft. to 2,800 ft. long, and the average length per job is about 800 ft. These jobs are scattered about the district and there was and is a great deal of moving of men, tools and material and miscellaneous work.

Practically the same pipelayers were employed from

TABLE III—COMPARATIVE COST OF SAND-CAST AND SAND-SPUN CENTRIFUGAL PIPE

Miscellaneous Short-Length Jobs, in 1928, Baltimore County Metropolitan District

Class No. 150, sand-spun pipe, in 12-ft. 5-in. laying lengths; Class B., A.W.W.A. sand-cast pipe, 12-ft. 5-in. laying lengths. Joint material, leadite, with lead every fifth joint.

Size, In.	Length, Ft. and In. Sand Cast	Length, Ft. and In. Sand Spun	Weight Per Ft., Lb.* Sand Cast	Weight Per Ft., Lb.* Sand Spun	Jointing Material Per Ft., Lb.* Lead Sand Cast	Lead Sand Spun	Leadite Sand Cast	Leadite Sand Spun	Men Required to Handle Pipe Sand Cast	Men Required to Handle Pipe Sand Spun	Man-Hr. Per Ft. to Lay Pipe Sand Cast	Man-Hr. Per Ft. to Lay Pipe Sand Spun	Cast Per Foot, Dollars: Pipe Sand Cast	Pipe Sand Spun	Hauling Pipe to Job Sand Cast	Hauling Pipe to Job Sand Spun	Labor to Install Sand Cast	Labor to Install Sand Spun	Jointing Material Sand Cast	Jointing Material Sand Spun	Total Cost Per Ft. Sand Cast	Total Cost Per Ft. Sand Spun	Saving Per Ft. Dollars
6	12-5	16-5	33.3	24.4	0.193	0.182	0.193	0.182	7	7	0.190	0.099	0.82	0.78	0.064	0.046	0.109	0.047	0.047	0.045	1.040	0.928	0.112
8	12-5	16-5	47.5	34.9	0.258	0.243	0.258	0.243	7	7	0.202	0.109	1.18	1.13	0.091	0.067	0.116	0.063	0.063	0.060	1.450	1.320	0.130
†10*	12-5	16-5	63.8	46.9	0.322	.....	0.322	.....	7	...	0.281	.....	1.49	.....	0.122	.....	0.162	.....	0.078	.....	1.852	.....	.....
12	12-5	16-5	82.1	60.4	0.387	0.365	0.387	0.365	8	8	0.440	0.186	2.03	1.92	0.158	0.116	0.249	0.106	0.093	0.089	2.530	2.231	0.299

*Leadite, with lead every fifth joint. †No 10-in. sand-spun pipe laid.

Labor rates, dollars per hour: Foreman, 0.90; calkers, 0.65; laborers, 0.50; average, seven-man gang, 0.578; eight-man gang, 0.568. The seven-man gang included one foreman, one calker, one roper, one lead-pot man and three men rolling and placing pipe; in the eight-man gang there were four pipe handlers.

Hauling: $3.85 per ton (1.925c. per pound) for either kind of pipe.

Materials: Pipe, sand-cast, $47.10, and sand-spun, $66 per ton. Lead, 7c. per pound. Leadite, 12c. per pound. Jute, 28c. per pound.

TABLE IV—MAN-HOURS PER FOOT USED TO LAY VARIOUS SIZES OF PIPE

Figures for work done in 1921 (summary only) and 1922 by Baltimore County Water & Electric Company, and in 1924-27 by Baltimore County Metropolitan District, and in 1925 by Baltimore County Metropolitan Essex-District. Some comparisons given between contracts embracing miscellaneous short sections and single contracts of greater length. Lead used for joints in 1921 and 1922; leadite, with a few exceptions, 1924-25; leadite, with lead every fifth joint, 1926-27. Work done by day labor for years 1921–25; by contract in 1926–27.

In 1921, the company laid 18,016 ft. of 12-in. pipe in 5,538 hours, equivalent to 0.307 man-hour per foot.

Size, In.	Wt. Per Ft., Incl. Valves	Total Ft. Laid	Total Hr.	Total Lb. of Pipe Laid	Man-Hours Per Foot: Max. Ft.	Min. Ft.	Ave.	Lb. Per Man-Hr. Per Hr.	Ft. Laid Per Hr. Per Man
A. 1922: Baltimore County Water & Electric Company									
6	35.30	76,968	22,938	2,717,095	0.905	0.058	0.298	118	3.35
8	49.37	9,277	3,597	458,005	1.175	0.232	0.387	127	2.58
10	66.99	17,456	7,500	1,169,377	0.677	0.352	0.429	156	2.33
12	84.91	5,990	2,718	508,611	1.267	0.201	0.453	187	2.20
		109,691	36,753	4,853,088				132	
161 jobs: min., 64 ft.; max., 2,473 ft.; av., 600 ft.									
B. 1924: Baltimore County Metropolitan District; miscellaneous length contract									
6	35.30	45,167	11,878	1,594,395	0.720	0.094	0.262	135	3.81
8	49.37	5,130	1,374	253,268	0.512	0.134	0.267	185	3.74
10	66.99	8,935	3,198	598,556	0.734	0.123	0.357	188	2.80
12	84.91	8,351	4,052	709,083	1.083	0.216	0.485	175	2.06
16	125.18	2,135	880	267,259	One job		0.412	303	2.42
		69,718	21,382	3,422,561				160	
64 jobs: min., 287 ft.; max., 2,580 ft.; av., 1,000 ft.									
C. 1925: Baltimore County Metropolitan District; Miscellaneous Length Contract									
6	35.20	55,393	12,750	1,955,372	0.648	0.088	0.230	153	4.34
8	49.37	18,254	4,979	901,200	0.672	0.203	0.272	181	3.67
10	66.99	10,544	3,497	706,342	0.759	0.197	0.331	202	3.02
12	84.91	11,130	7,799	945,048	1.232	0.235	0.701	121	1.42
16	125.18	923	1,048	115,541	One job		1.135	110	0.88
		96,244	30,073	4,623,503				154	
110 jobs: min., 84 ft.; max., 2,160 ft.; av., 800 ft.									
D. 1926: Baltimore County Metropolitan District, Miscellaneous Length Contract									
6	35.30	49,356	8,417	1,742,266	0.956	0.042	0.170	221	5.86
8	49.37	17,311	3,611	854,644	0.666	0.071	0.209	236	4.79
10	66.99	14,757	3,952	988,571	0.463	0.136	0.268	250	3.73
12	84.91	12,849	3,732	1,091,008	0.593	0.173	0.299	292	3.44
		94,273	19,712	4,676,489				237	
95 jobs: min., 66 ft.; max., 2,105 ft.; av., 900 ft.									
E. 1927: Baltimore County Metropolitan District, Miscellaneous Length Contract									
6	35.30	74,707	9,633	2,629,686	0.771	0.033	0.128	273	7.75
8	49.37	22,298	2,778	1,100,852	0.236	0.053	0.124	396	8.02
10	66.99	11,028	2,083	738,766	0.455	0.103	0.188	355	5.29
12	84.91	5,198	944	441,362	0.413	0.083	0.181	468	5.50
20	190.00	2,421	1,005	459,990	0.438	0.344	0.415	458	2.40
		115,652	16,443	5,370,656				327	
158 jobs: min., 70 ft.; max., 2,861 ft., av., 700 ft.									
F. 1925: Essex-Baltimore County Metropolitan District									
6	35.20	54,441	5,981	1,921,767	0.337	0.062	0.109	324	9.17
8	49.37	14,918	2,065	736,501	0.183	0.101	0.138	358	7.24
10	66.99	12,119	2,160	811,851	0.207	0.135	0.178	376	5.61
12	84.91	15,433	2,681	1,310,416	0.222	0.146	0.174	488	5.74
16	125.18	10,990	3,330	1,375,728	0.408	0.273	0.303	413	3.30
		107,901	16.217	6,156,263				380	
G. 1926: Baltimore County Metropolitan District, in Landsdowne									
6	35.20	37,730	5,395	1,328,096	0.494	0.058	0.142	246	6.99
8	49.37	5,908	850	291,678	0.289	0.098	0.143	343	6.95
10	66.99	1,738	316	116,429	One job		0.181	368	5.50
12	84.91	10,645	3,488	903,867	0.476	0.265	0.327	259	3.05
16	125.18	9,467	6,501	1,185,079	0.778	0.369	0.686	182	1.45
20	190.00	3,160	1,798	600,400	0.862	0.491	0.568	334	1.75
		68,648	18,348	4,425,549				241	
H. 1926: Baltimore County Metropolitan District, in Pikesville, Liberty Road, Belair Road, Philadelphia Road									
6	35.20	16,710	2,665	588,192	0.230	0.050	0.159	221	6.27
8	49.37	6,858	1,319	338,579	0.240	0.141	0.192	257	5.19
12	84.91	20,449	6,559	1,736,324	0.345	0.204	0.320	265	3.12
16	125.18	13,034	4,577	1,631,596	One job		0.351	356	2.84
		57,051	15,120	4,294,691				284	
I. May, 1924, to Jan., 1926, comparison of Baltimore County Metropolitan District, Miscellaneous Short-Length Contracts and Section Contracts									
Miscellaneous Contract No. 9-W and 13-W									
6	35.20	223,623	42,678	7,871,530	0.956	0.033	0.190	185	5.23
8	49.37	62,993	12,742	3,109,965	0.672	0.053	0.202	244	4.94
10	66.99	45,264	12,730	3,032,235	0.759	0.103	0.281	238	3.55
12	84.91	37,528	16,527	3,186,503	1.232	0.083	0.440	193	2.27
16	125.18	3,058	1,928	382,800	1.135	0.412	0.630	199	1.59
20	190.00	2,421	1,005	459,990	0.438	0.344	0.415	458	2.40
		384,887	87,610	18,043,023				205	
Section Contracts No. 3-W, 6-W, 8-W, 11-W									
6	35.20	108,881	14,041	3,832,611	0.494	0.050	0.128	273	7.75
8	49.37	27,684	4,237	1,366,759	0.289	0.098	0.153	323	6.53
10	66.99	13,857	2,476	928,281	0.207	0.135	0.179	375	5.59
12	84.91	46,527	12,728	3,950,608	0.476	0.146	0.273	310	3.65
16	125.18	33,491	14,408	4,192,403	0.778	0.273	0.431	291	2.32
20	190.00	3,160	1,798	600,400	0.862	0.491	0.568	334	1.75
		233,600	49,688	14,871,062				300	

1921 to 1925, consisting of twelve men per gang: one foreman, two yarners, two calkers, one man at lead pot and six men rolling pipe. In and since 1926 all of our work has been done by contract and the contractor reduced each gang to eight men by cutting out one calker, one yarner and two pipe rollers.

The number of man-hours used to lay pipe per foot and the number of pounds of pipe one man laid per hour by years from 1921 to 1927 (1923 omitted) are shown by Table IV, with indications as to whether the work was done under company or district ownership, and after 1922, whether the work was done under miscellaneous short-length-section contracts or single sections of greater length, as in Parts F, G and H of the table, where each contract was for work in one locality and more work was done per man as compared with the short-length contracts, when work was scattered over the entire district. This is further brought out by the last section (I) of Table IV, which summarizes all work done in four years in the Metropolitan District, divided into miscellaneous-length and section contracts. It will be noted that the average weight of pipe laid per man-hour in 1927 is much greater than in the previous years. This increase is due apparently to the experience gained by the contractors in handling the pipe, pouring joints and moving equipment from job to job.

The 427 jobs that were completed during the four years 1924-27 under the miscellaneous-length contracts are tabulated below according to the weight of pipe laid per man-hour, without regard to the size and according to the percentage of the total in each group:

Jobs	Per Cent
50 under 100 lb. per man per hour	11.4
131 from 100 to 200 lb. per man per hour	30.7
104 from 200 to 300 lb. per man per hour	24.4
68 from 300 to 400 lb. per man per hour	15.9
39 from 400 to 500 lb. per man per hour	9.2
25 from 500 to 600 lb. per man per hour	5.9
10 over 500	2.4

In 1927 we bought and laid some sand-spun cast-iron pipe in 16-ft. 5-in. lengths. This has resulted in so much labor saving that in our latest call for bids the following clause was inserted: "If the difference in bidder's price for laying 16-ft. length pipe is less than 25 per cent of that for laying 12-ft. length pipe, bids will be thrown out." No bidder made any complaint against this requirement, for a number of these men had experience in laying this pipe. As we have not laid an entirely sand-spun lead job to date, we cannot give a comparison between the two different jointing materials for both sand-cast and sand-spun pipe.

Although it has no direct relation to the topic under discussion, we take this opportunity to refer to the question that is very often raised by developers of new tracts as to the number of feet of pipe required per acre. We have found this to range from 150 to 200 ft. where the development is laid out in rectangular blocks, but it varies somewhat with the size of the lots and when the streets are curved. The average length in this district is about 185.5 ft. per acre, including all sizes from 6- to 16-in. of Class "B," and the average weight is approximately 9,020 lb. per acre.

Airports Planned at Chief French Seaports

At the request of the Union of French Chambers of Commerce, the French government, in collaboration with the various port authorities, has begun a study of the feasibility of a plan to attach a commercial airport to each of the important French maritime ports.

Features of Design, Coolidge Multiple-Dome Dam

Three Domes of 180-Ft. Span and 251 Ft. High—Reinforced to Resist Temperature Stresses—In Analysis Dome Assumed as a Series of Separate Arches Normal to Spring Line—No Contraction Joints Except in Buttresses

By Major C. R. Olberg
Assistant Chief Engineer, U. S. Indian Service

THE first multiple-dome dam ever built is now nearing completion in Arizona. The fact that it is being finished eight months ahead of contract schedule proves that there were no insurmountable difficulties of construction, and the absence of even minute cracks in the three domes, 251 ft. high and 180 ft. wide, in which there are no contraction joints of any kind, is a source of satisfaction to all who are connected with the work.

By act of Congress on June 7, 1924, $5,500,000 was authorized for the construction of a dam on the Gila River in Arizona to store water for irrigating about 100,000 acres, largely Indian lands, adjoining the Salt River irrigation project. The dam site is in the box canyon of the Gila about 9 miles below its confluence with the San Carlos River. The maximum discharge at the dam site in the past 35 years was 92,000 sec.-ft., and the mean annual runoff is about 400,000 acre-ft. All things considered, a dam extending 220 ft. above riverbed was selected as best, a structure of this height creating a storage capacity of 1,200,000 acre-ft. Because a full reservoir will back water up for 25 miles, silt at the dam was not regarded as a factor.

Excellent foundation rock was found at the dam site at a maximum depth of 23 ft. below streambed. Approximately, the canyon is here 300 ft. wide at the bottom, spreading to a width of 700 ft. at the top of the dam. Confronted with these basic conditions, the engineering force of the U. S. Indian Service made an elaborate investigation of the different types of dam in search of one that would permit the completion of the project within the limited funds available.

Because it fitted well into the requirements, particular attention was given to a novel type consisting of buttresses supporting inclined egg-shaped domes, the small end of the egg resting on the foundation while the wider portion, where the curve is of longer radius, is above.

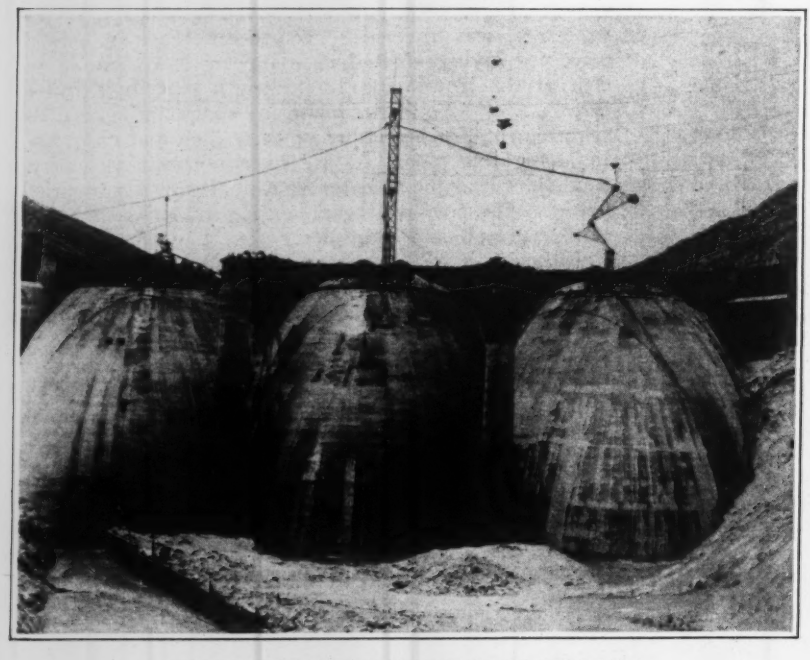
Plans and estimates were prepared for several types of dam, and the result of this detailed comparison as to relative quantity of material in the structure and relative total cost is given in the accompanying table:

Type of Dam	Relative Cost (Per Cent)	Relative Yardages (Per Cent)
Multiple-dome	100	100
Multiple-arch	102	67
Variable-radius arch	112	161
Arched gravity, no uplift	120	192
Rockfill	135	1,200
Arched gravity (50 per cent uplift)	140	213

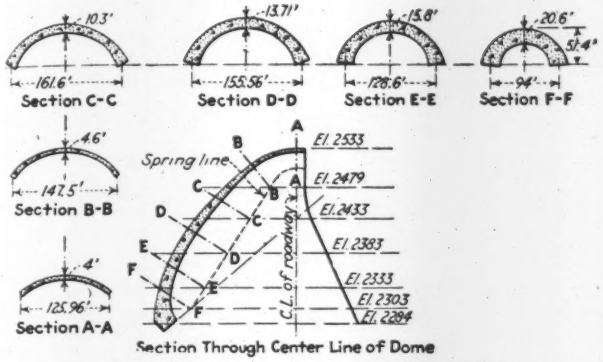
Two comments on this tabulated comparison are in order: (1) The computed unit stresses involved in the variable-radius arch would greatly exceed those in the domes. This was particularly marked at this dam site, where the considerable width of the canyon would make unit stresses so high in the variable-radius arch as to make that type of structure impracticable. (2) The cost difference is small between the multiple-arch and the multiple-dome types, but the latter gives a considerably heavier structure with similar unit stresses for about the same cost.

The sliding and overturning factors of multiple arch and multiple dome were taken as the same, and compression and shear stresses were nearly identical. The domes had the advantage, however, in that they were more massive, which indicated that a more massive structure and a more uniform texture of concrete could be obtained than with the thin section of the multiple arch.

The multiple-dome type is particularly adapted to wide canyons where good foundation is available and the dam height is to exceed 200 ft. The buttresses are made massive and are inherently stable, since they increase in thickness from their narrowed sections immediately below the domes to the foundation. Hence they are not subject to a tendency to buckle, and no lateral braces or face walls are needed. The upstream face of each buttress flares out to meet the short-



MULTIPLE-DOME DAM NEARING COMPLETION, UPSTREAM FACE
Wood panels still in place indicate level where truss from supports began.



TYPICAL DETAILS OF DOMES AND BUTTRESSES

ening radius of the dome and the downstream face is sloped to secure a satisfactory overturning factor and to reduce the pressure on the foundation. The shape of the buttress can be made such that practically all tension stresses due to load are eliminated, while compression and shear are held within reasonable limits. The comparatively great thicknesses of buttresses and domes give protection for the steel used to prevent temperature cracks, and in cold climates is a safeguard against concrete deterioration due to frost.

The design of the domes is not so complex as might be imagined, nor is it difficult to avoid tension and keep compressive stresses within reasonable limits. For any desired unit stress limit and using the elastic arch theory, a series of reinforced-concrete arches is designed to carry the water load, which of course varies with depth. By varying the ratio of rise to span of the arches there is ample range for a practical design to fit each case. For purposes of calculation each dome is considered as being composed of a series of independent arches normal to the spring line, no account being taken of the strengthening effect of the dome. As the depth increases the arch is thickened and the radius of curvature and span are shortened. The calculations can therefore be made with as much precision as in a concrete arch bridge.

Other inherent advantages as compared with vertical arches are that when subjected to water pressure the shape of the dome practically eliminates vertical cantilever action, thus doing away with objectionable tension stresses, and when the reservoir is empty the inclination of the dome and the weight of masonry tend to eliminate the tensile stresses due to temperature and shrinkage.

The extrados is a surface of revolution generated by rotation around an inclined axis and through an arc varying from 180 deg. at the base to about 80 deg. at the crest. The intrados is not a surface of revolution (because of the thickening of the arch elements at the abutment) but is composed of a series of intradosal curves on three-centered arches. The outer surface at the top and the inner surface at the base are portions of true spherical domes.

At the Coolidge dam it was desired to simplify the design by keeping the arch elements of the domes symmetrical with respect to the two buttresses and thus to get uniform secondary stresses. Excavation for the domes was therefore carried into the rock for an equal distance on both sides of the canyon. This is indicated in the accompanying illustration.

Stresses in the domes due to hydraulic thrust, temperature variations and to dead load are all in compression except for a small area near the base, where the most unfavorable loading produces a tension of about 40 lb. per sq.in. Thus the major function of the structure is fulfilled by loading the concrete solely in compression. The maximum compressive stress in the domes will be about 586 lb. per sq.in., and in the buttresses 400 lb. per sq.in. Pressure on the buttress foundation will reach a maximum of 20 tons per sq.ft.

There is extensive use of reinforcing in the domes for (1) preventing temperature shrinkage cracks; (2) anchoring the concrete to the foundation; and (3) transferring shear to the buttresses as the domes approach the crest. The tension due to temperature variations when the reservoir is empty may reach a maximum of about 140 lb. per sq.in., and this is provided for in full by two layers of steel bars placed 6 in. from the intrados and extrados surfaces, respectively. With a full reservoir and under the compression of the arches caused by hydraulic thrust, all this tension is overcome, of course, the temperature steel being put in to carry the tension that would occur only during construction and whenever the reservoir is empty.

The steel rods used to prevent temperature cracks vary from $1\frac{1}{4}$ in. diameter at the base of the domes to $\frac{3}{4}$ in. at the crest, but for convenience in construction are put on a uniform spacing of $8\frac{1}{2}$ in. on centers from base to crest. The bars were laid normal to the spring line of the arch and thus are parallel to the arch elements into which the domes are assumed to be divided for stress analysis purposes. The temperature variations in the concrete were

DOWNSTREAM VIEW OF THE COOLIDGE DAM
Only two buttresses were used, the edges of the outer domes being bedded in the rock.

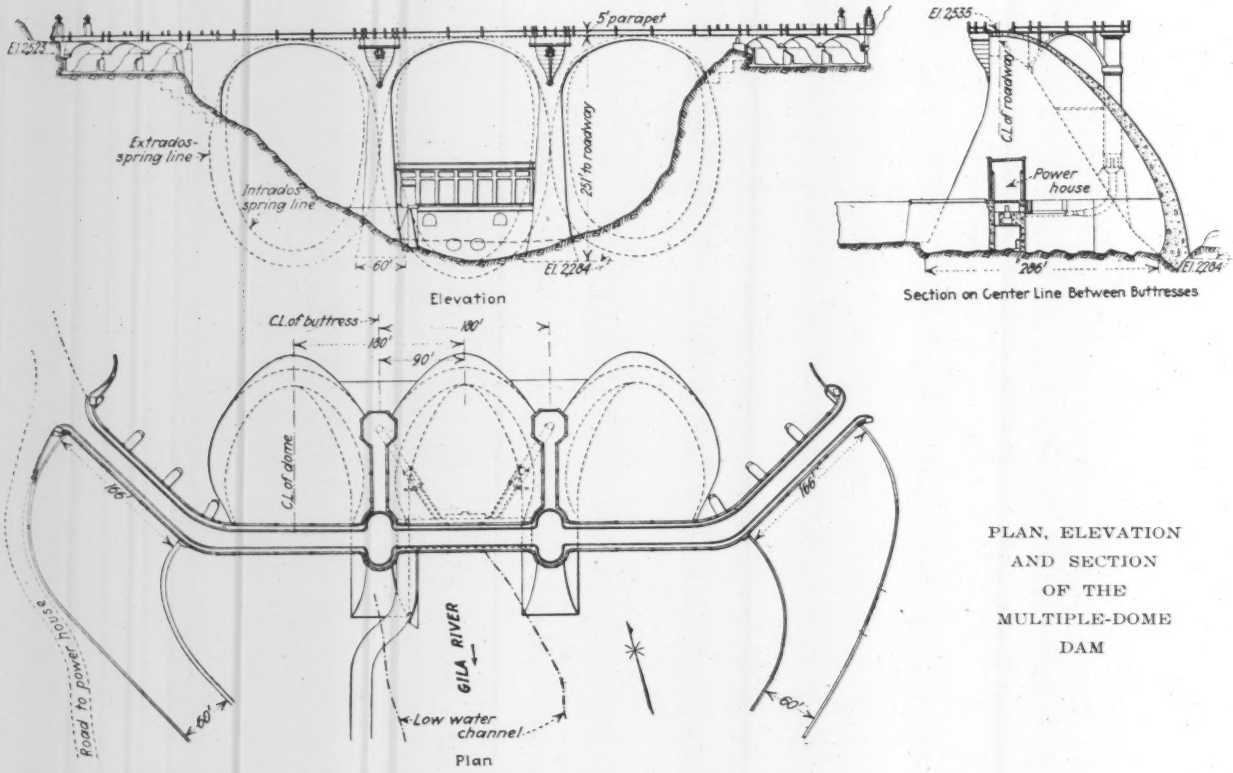
assumed as 70 deg. F. (35 deg. F. each way) at the crest, where the dome thickness is 4 ft., decreasing to 30 deg. F. (15 deg. F. each way) at the base, where the crown of the arch is about 20 ft. thick.

In domes and buttresses alike, anchor steel was put in to secure as good a bond as possible with the foundation, and holes for grouting the foundation after concreting were drilled at frequent intervals. The buttresses were designed without allowance for uplift, but anchor steel was put in to resist uplift. Anchor steel in domes and buttresses consists of 1¾-in. bars grouted into holes drilled 8 ft. into the rock on 6-ft. centers for the buttresses and 15-in. centers for the domes.

Steel to carry shear—that is, to transfer arch thrust into the domes. During construction, as the pouring neared the upper limits of these joints, and before the steel tie above them had become effective, there was observed a very slight movement in one of the joints.

The sliding factor of the dam with the reservoir full is 0.73 without uplift. With 50 per cent uplift at the heel, diminishing to zero at the toe of the buttresses, it is 0.76. With the reservoir full the overturning factor without uplift is 2.83 and with uplift 2.

Proportioning and control of the concrete mix were carried out in accordance with modern practice. Specifications call for concrete as shown in the accompanying table, which is, roughly, 1 bbl. of cement per cubic yard of concrete in the domes and 0.9 bbl. per cubic yard in the buttresses. The water-cement ratio varied from 0.9 to 1.1.



PLAN, ELEVATION AND SECTION OF THE MULTIPLE-DOME DAM

	Cement	Sand	Rock ¼ to 2½ In.	Rock 2½ to 7 In.	Specified Strength (28 Days)	Actual Strength (28 Days, Av.)
Buttresses	1	3.1	3.6	3.2	1,800 lb.	2,552 lb.
Domes....	1	2.7	3.1	2.8	2,200 lb.	2,922 lb.

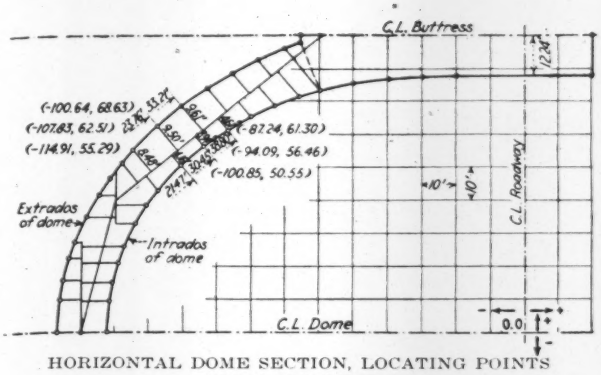
In addition to laboratory control tests, slump tests were made regularly on the dam with samples taken from concrete after delivery into place. The maximum allowable slump was 5 in., and this was followed rather closely, because inspectors were instructed to watch carefully for excessive water content and on the other hand chute slopes were set so that a drier mix would be likely to cause clogging.

The spillways on either side of the dam proper were worked out largely as the result of experiment with models on a 1 to 120 scale. As originally designed, two longitudinal vertical fins or vanes were to be built into each spillway channel to aid in guiding the flow. These fins were tried in the models without success and were not used on the dam. The model showed the best results

to the buttresses near the tops of the domes— was placed in the form of additional layers between the two layers of temperature steel. These rods are all 1¼ in. in diameter, spaced 8½ in. on centers. The bars of successive layers are not parallel, each layer being placed at an angle with the one preceding, the arrangement being calculated to develop greatest strength in shear.

Although the crest of each dome is cast monolithic with the arch ribs of the highway bridge, the latter was figured as a separate structure and is reinforced simply for roadway stresses. It is not expected to carry any thrust from the crest of the dome.

Reinforcing was put in the buttresses in horizontal layers 28 ft. apart, as shown in the drawing. Because of the large size of the buttresses and the probability that there would be some tendency to crack, two contraction joints were put in along the lines of principal stress in each buttress, as shown. These joints extend from a point near the spring line of the dome arches down to the foundation. Across and above their upper ends ample steel was used to prevent any extension of buttress cracks



HORIZONTAL DOME SECTION, LOCATING POINTS BY ORDINATES

with a warped surface in the bottom of the channel, in which the inner side was made quite deep. This section was therefore adopted and is expected to give maximum capacity without spillage on the curve. Each spillway has a calculated capacity of 60,000 sec.-ft. when flowing to full depth of 22 ft. over the weir.

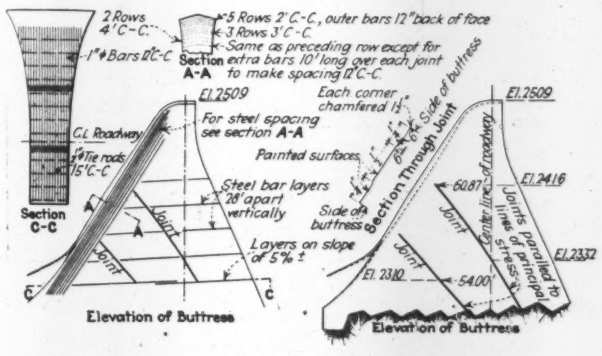
To provide ready means of checking measurements and to simplify calculations the dam site was surveyed and hubs were set so that the entire area was covered by a network of squares 10 ft. on a side. Thus there was no point in or near the dam more than 5 ft. from a line that conveniently could be established by instrument and checked with a right-angle intersection.

As the domes were built up, a large number of points had to be set by transit to insure true alignment of forms. These points were calculated to 0.1 ft. from reference points and radii which determined the shape of the domes. They were then plotted on the co-ordinate system as illustrated by the drawing. By use of these sheets the survey parties set the actual points in the field. While the progress in pouring the domes was rapid, two transit parties were kept busy on this work.

Under the central dome a 10,000-kw. hydro-electric plant is to be built, served by two penstocks whose control gates will be operated through towers on the upstream face of the structure.

The dam is being built by the U. S. Indian Service under the general direction of the writer; H. C. Neuffer, designing engineer; J. A. Fraps, assistant designing engineer; C. H. Southworth, construction engineer; and E. L. Rose, electrical engineer. Fred A. Noetzli has been consulting engineer throughout the work and with L. C. Hill constituted the first board to pass on plans. Later, a second board consisting of Gen. W. C. Langfitt and A. J. Wiley was appointed to review the plans. It was on the joint recommendation of these two boards that the multiple-dome type was adopted for this site. Contract for the construction was awarded in December, 1926, to Atkinson, Kier Brothers & Spicer Company.

[An article on novel construction features of this unusual structure will follow.—EDITOR.]



CONTRACTION JOINTS AND REINFORCING IN BUTTRESSES

Paris Water-Supply Project Under Consideration

The project of bringing water to Paris from the bend of the Loire River, which has been under consideration by the municipal council for many years past, has now been taken up in a commercial form by a syndicate especially organized for this purpose. According to *Les Travaux Publics*, the syndicate is being incorporated under the name of Société d'Etudes pour le Developpement de l'Alimentation en Eau de la Region Parisienne. The project has been adopted in principle several times in past years, only to be abandoned in fact because of the apparently excessive cost, and more particularly because the lower Loire was considered navigable, it is said.

Several lower reaches of the Loire have now been removed from the list of navigable waters, the report states, and the port improvements at St. Nazaire are intended to provide deep-water accommodations even in the hypothesis that the bend of the river be practically dried up. In any event, the affluents below Tours already provide most of the water flowing through in summer.

More Data Sought in International Water Question

No discussion of policies to be followed in the distribution of the waters of the Rio Grande, the Colorado and the Tia Juana will be undertaken by the International Water Commission until more fundamental data have been gathered and compiled. The recent meetings of the commission in El Paso and in Juarez were devoted to discussions of plans for gathering the information that would be necessary for the commissioners to have before they can begin to formulate their recommendations.

Practically all of the data needed in United States territory are available, hence the task is largely one of compilation. On the Mexican side considerable original fact finding must be done and some mapping undertaken. While in the Southwest the American and Mexican commissioners inspected the principal regions involved. Progress reports will be submitted at a meeting next fall, which probably will be held in Washington.

Dr. Elwood Mead is the chairman of the American section of the commission. The other members are Gen. Lansing H. Beach and W. E. Anderson.

Scranton Water Supply and Mine Settlement

Subsidence due to coal mining is not likely to cause much damage to water-supply mains in Scranton, Pa., "so long as the present program of mining and good cooperation is carried out," says a report just issued by the National Board of Fire Underwriters, New York City. Occasional leaks and some breaks may be expected in distributors, with a rupture of an artery perhaps once a year. The pipes are well gated and are carefully watched above by the water company and below by the mining companies. Emergency repair crews are ready at all times. "The records show that no fire has resulted from mine settlement."

Plan of Water-Works Management at Madison, Wis.

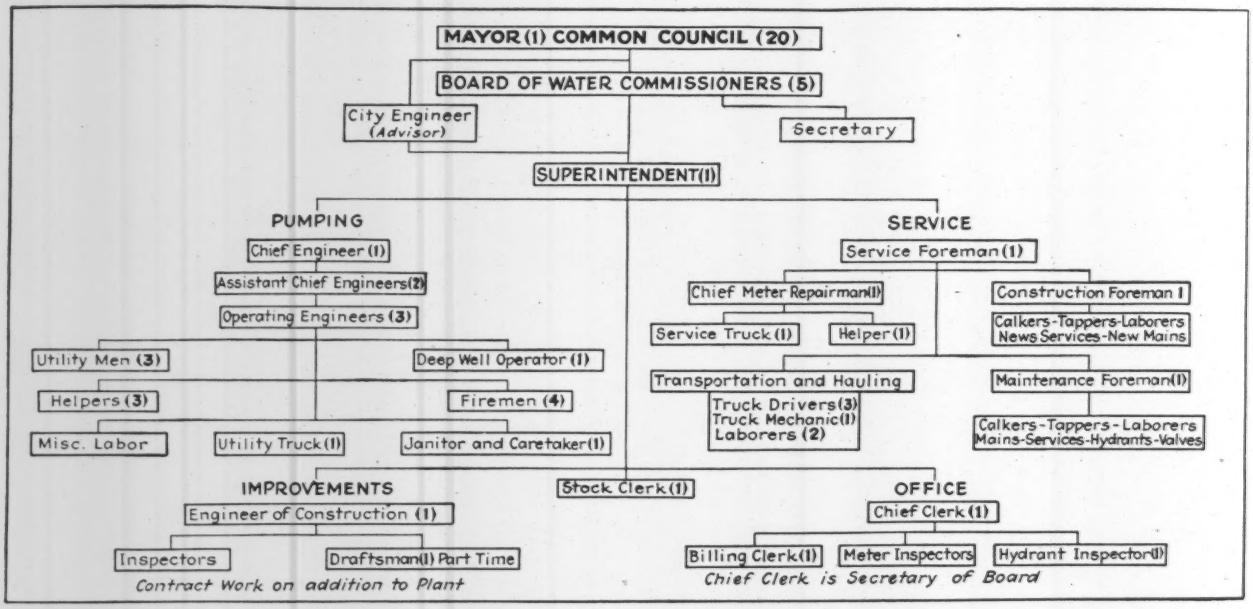
Non-Political Organization, Long Tenure of Office, Definite Responsibility and Complete Records

By L. A. Smith
Superintendent of Water Department, Madison, Wis.

SUCCESSFUL management consists of engaging capable men and providing an organization in which they can work most effectively. We all agree to this in the abstract, but it is quite difficult to work out the details of organization so that good results are obtained. That attention to this matter pays is shown by the operating results of the water-works of Madison, Wis., which are here briefly summarized to justify the description of our methods which follows. In the last ten years the value of the Madison water-works, exclusive of special assessments, has increased from approximately $1,000,000 to more than $2,000,000. In 1918 the profit, after paying operating expenses, including taxes and depreciation, amounted to less than $25,000. In 1927, without any change in rates, the profit amounted to nearly $100,000. The average annual water bill in Wisconsin cities of more than 10,000 population, based upon an annual consumption of 10,000 cu.ft. per year, is $22.20. The annual water bill in Madison on the same basis is only $11.50, or only slightly more than half of the average bill. These two facts indicate a sound financial condition.

The system is administered by a board of five water commissioners, including the mayor and a member of the city council, both ex officio, the latter chosen by a majority vote of the council. The three other commissioners are appointed by the council, also by a majority vote, one each year for a three-year term, and serve without pay. The mayor has no part in the choice of his four fellow members on the board, except in the case of a tie vote in the council. The composition of the board and the overlapping terms of the members are factors designed to keep the department out of politics. Through reappointment, the tenure of office of the three "citizen" members has been long. The present three have served 22, 17, and 12 years respectively. Under these conditions we have been able to work out our problems without considering them from the political angle. This fact and the type of organization are undoubtedly the two most important reasons why the Madison water-works are able to make a successful showing.

I do not mean that the manner of selecting members of the water board is guarantee of non-political management, but rather that in our case it has so resulted. As a matter of fact, the water board could be made subservient to the council, as the following analysis will show. The twenty aldermen who compose the city council are elected for terms of two years, but half the aldermen (one from each of the ten wards) retire every year. In two years' time, therefore, a majority or even the entire membership of the council might change, and two of the "citizen" members of the water board be displaced. Meanwhile a new mayor might be elected, thus changing a third member of the board, and if one of the councilmen not re-elected should be the council-member of the board, that would make a fourth change. It would be quite possible for three members of the board, a majority, to be replaced in a single year. Water bond issues and yearly budgets of the water department must be approved by the council, and while in the last ten years both budgets and proposed bond



ORGANIZATION CHART OF WATER DEPARTMENT, MADISON, WIS.

Superintendent — Besides the functions stated in the text, the superintendent is purchasing agent. He is assisted by the stock clerk, who is in touch with all divisions outside the main office and in contact with chief clerk in checking material; also acts as time clerk.

Pumping—The chief engineer has complete operating and maintenance charge of the three pumping stations, and is responsible for costs.

Service—Lays new mains and services except when done by contract; maintains distribution system, including reservoirs, but excepting meter and hydrant inspection; has charge of unloading coal and delivering it to pumping station, and of various items of miscellaneous work.

Office—Besides work specified on chart, prepares vouchers for payment.

Improvement—In charge of all construction financed by new capital, if done by contract and of the physical records of the distribution system.

issues have been approved almost invariably by a unanimous vote of the council, quite the contrary might happen any year. It is therefore apparent that it is the character of the mayor and council and the force of public opinion behind them rather than the way the water board is chosen, or even the fact that there is a board, that is the fundamental reason why the water-works are ably administered.

The water department keeps its own books and has them audited yearly by a firm of certified accountants. The city auditor, who is elected annually for a one-year term, signs all purchase orders of the water department, but only to certify that funds are available.

The board appoints a superintendent and a secretary. The other employees are appointed directly by the superintendent, with the approval of the board. There is no civil service commission in Madison. The city engineer acts in an advisory capacity in fixing the location and grades of water mains and services in the streets and alleys. Materials purchased in large quantities—such as pipe, hydrants, valves, brass goods, meters and coal—are advertised and contracts awarded with the approval of the board of water commissioners.

The work of construction, operation and maintenance is in charge of three divisions—pumping, service, office, and improvement. The duties and staffs of the divisions are shown by the organization diagram and the notes below it.

A water-works superintendent should have personal knowledge of each employee under him, as far as possible. Each morning I visit the service building and discuss with the service foreman the work for the day. If any material or supplies are needed, a requisition is made out and signed by the foreman. I also visit the pumping station at a specified time and discuss with the chief engineer the work which is being done there, and collect from him any requisitions for material which he will need. My office is in the city hall, which houses also the chief clerk, billing clerk and meter inspectors.

Each division head is given ample opportunity to work out his own ideas and to take his full share of the responsibility, but before any change in policy or any unusual procedure is adopted, the approval of the superintendent is required. I find that it is extremely important that each group head solve all problems that come to him in the manner which seems advisable to him rather than in the way in which he thinks the superintendent would solve them. I do not believe in handicapping a man by asking him to do what he thinks I would do, but much prefer that he proceed in the way which seems to him to be advantageous and allow the results to demonstrate the soundness of his judgment.

In many of the smaller cities, particularly those having municipally owned water-works, there is no definite division of responsibility. The men are shifted from one type of work to another and from the supervision of one man to another in a way which renders their services ineffective and the results obtained unsatisfactory.

I believe in complete records, and every division has a man whose duty it is to keep adequate records. Each month a report is submitted to the superintendent showing the work done during the preceding month, together with the cost. Natural rivalry among men doing the same sort of work should be encouraged. The value of this is shown by the following instance: At our main pumping station, which is a steam station, we have a Venturi meter on our boiler-feed line and coal scales to measure the quantity of coal burned. We have four firemen, each man working six eight-hour shifts a week. At the end of each shift the operating engineer reads the Venturi meter and the coal scales and computes the boiler evaporation, entering it on a chart in the boiler room. Each fireman, when he comes to work, knows exactly what his evaporation was during his preceding shift, and also what the other men were doing. When this was first done our boiler evaporation was approximately 7 lb. of water per pound of coal, but has been increased, with hardly any urging on our part, so that the average last year was 8.4 lb. Practically all of the men have taken extension courses on combustion at the University of Wisconsin and have not only a practical knowledge of the proper method of firing but also sound theoretical information.

Teamwork and co-operation are essential to proper results, and these can be best obtained by paying good salaries and letting the men know that good work is appreciated.

Blowing Odor Out of Water Supply of St. Paul With Air

By Ross A. Thuma
Superintendent of Water Filtration, St. Paul, Minn.

AERATION by means of compressed air has been used for about 2½ years at the water-purification plant of St. Paul, Minn., to eliminate odors from the water supply, which is drawn from the Mississippi River via Chain of Lakes—four lakes—and subjected to rapid filtration. Complaints of odors have been reduced 95 per cent (estimate) compared with the 2½ years the plant was operated before aeration. Before describing the aeration plant brief consideration will be given to the causes of odors in water and means for their removal.

Perceptions of odor and taste in drinking water are so closely associated that few people distinguish between them in making complaint of the quality of the water. Generally speaking, only those materials that are soluble produce the sensation of taste, while those that occur as gas produce the sensation of odor. With this statement in mind, it becomes a comparatively simple piece of reasoning to distinguish between the two sensations. The cause of odor in a water supply may then resolve itself into but one cause—namely, that of dissolved gases in the water. Gases are the byproducts of organic decomposition and are usually associated with bacterial activity. Consequently, as long as water contains any organic material, gases may be liberated by its decomposition, and odor developed. Temperature plays an important part in bringing out the odor. The amount of gases held in solution increases as the temperature decreases. During the winter months when the temperature is low the water is capable of holding the maximum amount of dissolved gases. When the water passes from the service pipes into and through the warm pipe lines of a basement, the gases are driven out of solution by the increase in temperature. The result is that when the water is drawn from the service tap foaming results and frequently odor is noticeable.

Purpose of Aeration—Aeration may be used either to add oxygen to water or to sweep malodorous gases out of it. In a water that contains even a small amount of organic material it is desirable to maintain an excess of dissolved oxygen. The free oxygen will aid in bring-

AERATOR COMBINED WITH CHEMICAL MIXING CHAMBER
Compressed air applied from below through perforated pipe.
Alum solution enters over weir at far end.

ing about decomposition of the organic material with the minimum amount of malodorous gases. Stagnation of water will follow where the dissolved oxygen content is reduced to a minimum. The removal of malodorous gases from public water supplies by the process of aeration is being more and more practiced. Where surface water is used as a source of supply, aeration becomes an essential part of the purification process for the production of a satisfactory quality of drinking water. The gases are swept out of the water by aeration in much the same manner as a room is ventilated. Aeration, then, accomplishes the double purpose of adding oxygen to the water and removing gases which may be the cause of unpleasant odor. A public water supply ought to be kept free from repugnant odors, the presence of which may drive water drinkers to seek another source of water of questionable sanitary quality. Every encouragement ought to be given to promote the use of the approved public water supply.

Aeration at St. Paul—Aeration at St. Paul is effected by air under 5 to 6 lb. pressure delivered through 2-in. galvanized-steel pipe, perforated with a double row of $\frac{3}{16}$-in. holes, spaced 12 in. c. to c., set at an angle of 45 deg. The air is applied from below to the water stream as it enters the mixing chamber. The aluminum sulphate solution is applied by overflow from a trough above. The compressor has a delivery capacity of 127,235 cu.ft. per day at present speed, and is driven by a 30-hp. electric motor. It is operated 24 hours a day with no addition to the operating staff and is of sufficient capacity to supply air for aerating 50 m.g.d. Use of 6,000 to as low as 3,000 cu.ft. of air per 1 m.g. of water has been satisfactory. Besides the motor and compressor, the only construction cost was a concrete base, 8x10 ft. in plan, and 200 ft. of air pipe, of which 28 ft. is perforated.

The air removes the malodorous gases, the carbon dioxide, and saturates the water with free oxygen. The violent agitation of the water by the air current aids in bringing the maximum amount of water in contact with the floc during its formation. The chlorine requirement of the water is slightly reduced by aeration. A reduction of from 1 to 2 lb. of chlorine per 1 m.g. of water followed the adoption of aeration. The factors operating to reduce the chlorine requirement are difficult to determine. Several factors were in operation at the same time, such as the increased efficiency of the alum floc, the removal of dissolved gases—probably capable of being chlorinated — and the addition of free oxygen.

Cost—The capital outlay for the aeration plant, including labor, totaled $1,600. The average annual operating cost is $1,730, including no allowance for labor or overhead. Capital charges on the plant at 4¼ per cent for interest and 15 per cent for depreciation are $308, making a total annual charge of $1,938. During the two years under consideration an annual average of 46,440,775 cu.ft. of compressed (6 lb. pressure per sq.in.) air was delivered for the aeration of 8,000 m.g. of water yearly, making the average total cost of aeration 24c. per m.g.

Fountain aerators would have necessitated a much higher construction cost than was required for the compressed air apparatus, considerable more space, and also housing against the cold weather at St. Paul, where the temperature sometimes averages —25 deg. F. for several days and has a minimum record of —35 deg. F. The total pump lift would have had to be increased some 10 to 20 ft. to give the necessary head for the fountains.

Separate Sludge Digestion in Primary and Secondary Tanks

Separate sludge digestion at the sewage-works of Bath, England, making use of both primary and secondary tanks, reduced by 46 per cent, or from 88,000 to 40,000 long tons, the weight of sludge sent to the drying beds in the three full working years ended March, 1927. The sludge thus treated is drawn from two sets of Dortmund tanks, the first of which receives sewage after passing through grit chambers, while the second set (humus tanks) receive effluent from sprinkling filters.

The two detritus tanks are each 10½x50x7½ ft. deep. The six primary settling Dortmund tanks, with conical bottoms, are 50 ft. in diameter and 45 ft. deep. The Dortmund humus tanks are 35x33⅓ ft.

The primary digestion tanks are in two units of 1,230 short tons each, adapted from old stormwater tanks. The secondary digestion tanks comprise some 249-ton (short) units. Sludge is pumped successively to the two primary units and from them in like manner to the nine secondary units and from the latter to ash sludge-drying beds, the latter providing 1 sq.yd. of surface to 3½ persons, which will be increased to a 3 to 1 basis. In each digestion tank 2 ft. of old sludge is left to inoculate the additional sludge pumped to it. Supernatant water from both sets of tanks and the drainage water from the drying beds are returned for passage through the works.

The foregoing information is taken from a paper by F. P. Sissons, city engineer, Bath, England, read before the Association of Managers of Sewage Works, and printed in the London *Surveyor*, July 13, 1928.

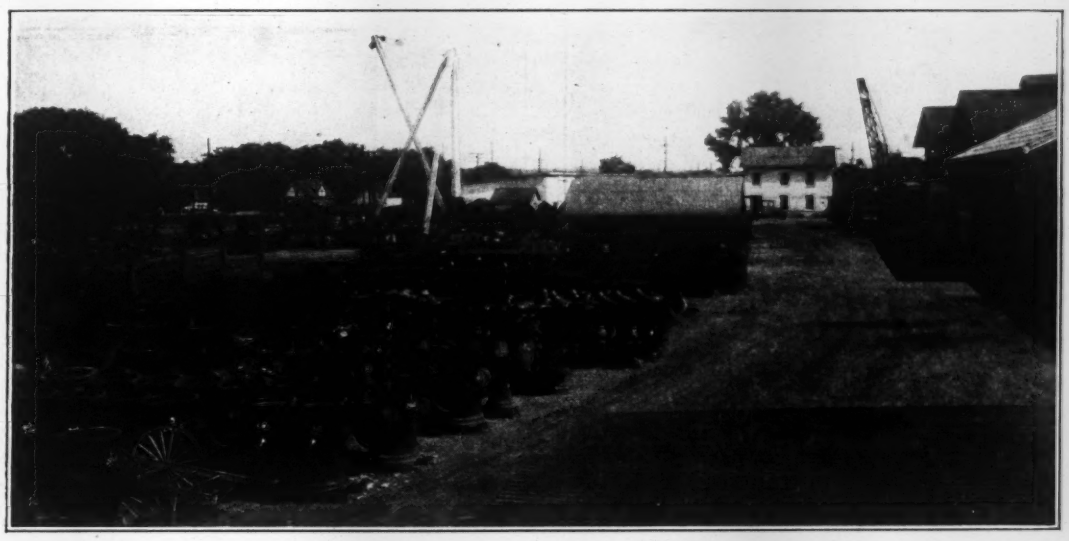


Fig. 1—Looking Across Denver Water-Works Storage Yard. About Half the Space Devoted to Pipe and Specials Is Shown.

Storage Yards and Buildings of Denver Water-Works

Stock Arranged to Conserve Space, Provide Automatic Cumulative Counts for Quick Inventories and Assist Buyer by Maintaining Live List of Supplies

EVOLUTION of the water-works storehouse and storage yard has had to keep pace with the rapid material development of the field. While the replacement of the horse-drawn vehicle by motor-driven equipment may be striking, the use of excavating machinery instead of man power has brought to the water-works official a new necessity of providing spare parts and shop facilities for rapid repair. In the old machineless days 60 men comprised a full complement for a pipe-laying gang, whereas now fourteen to twenty men fully equipped with pavement breakers, air spades, trench excavators, pipe-handling cranes, air-driven calkers and gas-driven backfillers can lay twice as much pipe. Availability of parts for continuous construction thus becomes of prime necessity. Repairs cannot wait on factory deliveries any more than emergencies in the distribution system can wait for new pipe specials from the foundry. How well the Denver plant is equipped to handle contingencies as well as regular demands is told in the following article.

—EDITOR.

ARRANGEMENT of stock in the storehouse and material yard of the Denver municipal water-works is such that inventories may be taken quickly. The basis is that of accumulated counts. The method as worked out is to stack material in definite multiples and number those multiples, either on the top piece of each stack or pile or on a scale alongside. If pieces are small, they are stacked in containers or trays with the amount contained marked on the tray. The highest numbers, which are the most accessible, naturally are used first. The main reason for the system is to speed up the taking of inventory of the 2,380 items in the storehouse. It can be taken now, including nuts, bolts and similar small items, in two to three hours, whereas before the system was installed it required as many days. In consequence of the short time required, inventories are usually made on the first of every month.

Denver is farther away from the source of many water-works materials constantly in demand than almost any other city of its size east of the Rocky Mountains, so that it is quite necessary for prudent operation to maintain sufficient stock for almost any emergency call. Pipe comes from Alabama and the East. Valves are bought on the Eastern seaboard, but hydrant parts are cast locally and machined in the West Denver shops.

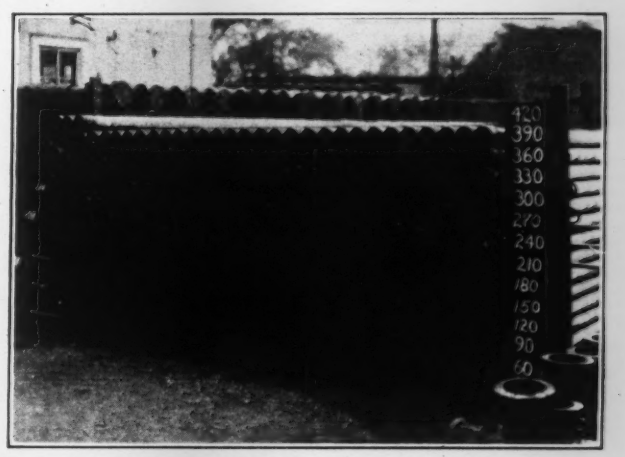


FIG. 2—STACK OF GALVANIZED-IRON PIPE WITH "GAGE BOARD"

Thirty pipes per layer are indicated by the gage board at the side. To get total count it is only necessary to note the total made by the upper complete layer and add the three pipes in the top row, making 393 in the pile.

FIG. 3—VALVE BOX BASES NESTED FIFTEEN HIGH
Numbers of cumulative count are painted on the top base. In front are stems, tops and lids wired to the tops.

FIG. 4—LARGE EQUIPMENT MUST BE STORED OUTSIDE
Dragline excavator and three tanks used to supply customers when water is shut off for repairs.

Corporation and curb cocks come from at least 1,000 miles away. This isolation, then, makes frequent inventories desirable. Frequent inventories are also of great assistance in careful buying. Some commodities fluctuate in price with a certain amount of periodicity, but most items do not, although they have their ups and downs. Auto tires are low now, but deterioration is such that only six months' supply is kept on hand. The past inventories tell how many tires the 95 motor vehicles (50 are Model T Fords) require for the different seasons, and orders can be placed accordingly to keep six months' supply on hand.

The storehouse, shops and yards are located at the now little-used West Denver pumping station, built in 1880 about 1½ miles southwest of the center of the city. This stand-by emergency station has been operated only eight days since September, 1926, and will ultimately be abandoned and the space be given over entirely to storage and shops.

Abandonment of the West Denver 12-m.g. reservoir, once a material factor in the supply to the city, is also contemplated, the eight-acre site to be filled in and used for additional storage space. The accompanying sketch map shows the buildings and the location of the various stock piles and equipment for construction and maintenance. The city does practically all of its own extension work, so that a full line of tools and machinery, from picks to excavators, is provided. Space must be available for storage of this construction equipment in winter and when extension work is slack. There must be machine shops for repairs and a stack of repair parts. There is, therefore, necessity for conserving space by careful planning and compact arrangement until there is available the prospective housing in the old pump house and area in the old reservoir site.

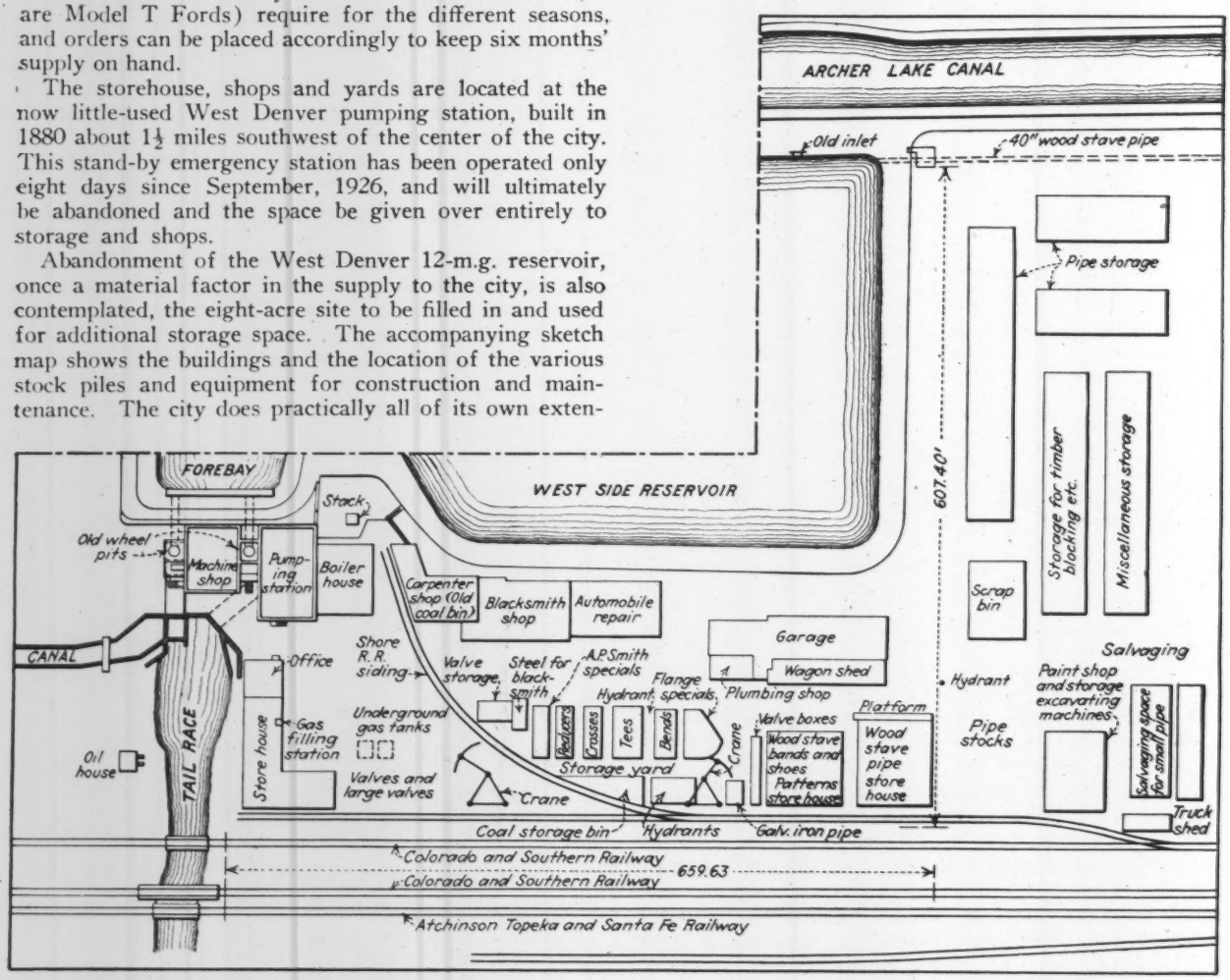


FIG. 5—GENERAL PLAN DENVER WATER-WORKS STORAGE YARD AT WEST DENVER PUMPING STATION
Abandonment of the pumping station and reservoir is contemplated, since the pumps are obsolete and seldom used. A part of the station is already used as a machine shop.

The arrangement of the buildings was not planned as it is, but is a development and evolution during a period of more than 40 years. Stables have given way to garages and a water-turbine room to a machine shop. Here and there are additional buildings, or extensions to old ones have been made, but generally speaking the space is well occupied and the equipment up to date. This is particularly true in the shops, where $11,750 has been spent on equipment in the last two years. Railroad spurs are available for unloading carload lots and heavier items.

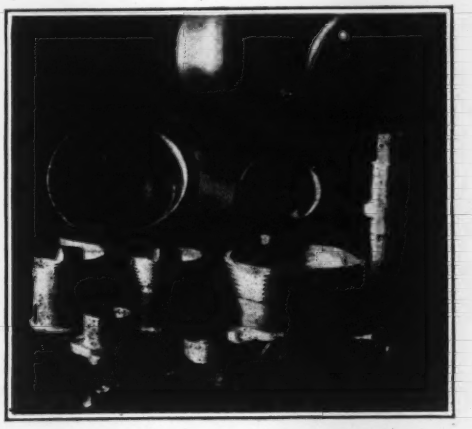


FIG. 6—HYDRANT PARTS MACHINED IN WATER-WORKS SHOP

Machine Shop—A partial list of the special tools and equipment in the machine shop will support the claims of the foreman that few parts cannot be duplicated and repaired in his shop. Oxyacetylene and electric welding outfits, both portable, are kept on hand for regular and emergency work. A furnace, three forges and one 250-lb. and one 500-lb. power hammer form the mainstay of the shop. A grinder with 5-hp. motor, a 2½-in. bolt machine, a punch and shear machine, a high-speed power saw and a 28-in. drill press are tools recently installed. Small tools like picks, bars and calkers are all made in the shop, as well as such specials as tie-backs for dead-end plugs.

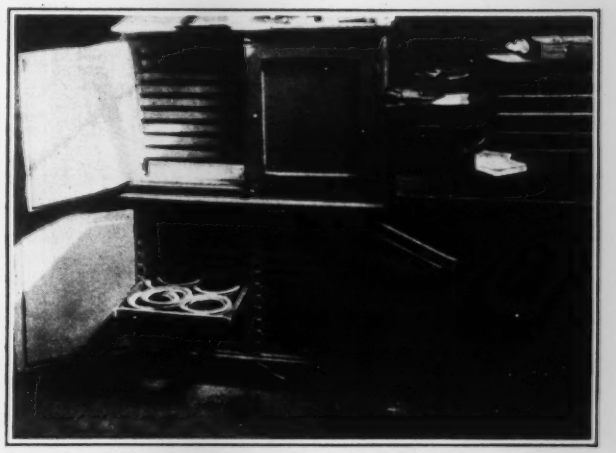


FIG. 8—HUMIDOR TO KEEP RUBBER GASKETS MOIST
Note the four loose-leaf inventory books in shelves on table at right of humidor.

Stock Piling—As examples of the method of outdoor storage, galvanized-iron pipe and valve boxes are shown by the accompanying views. The 3-in. pipe here shown is laid on sleepers in rows of 30 each between uprights made of old rails. A scale alongside indicates at a glance how many lengths of pipe are available in the full rows, and those in the broken rows at the top are quickly counted. Thus in the stack shown are 393 lengths. Valve bases are nested fifteen in a stack, with the total number available painted on the top piece. Stems, tops and lids wired to the tops are assembled and stacked on the side with numbers on the stem. For rounds, flats and squares used in the blacksmith shop a rack with numerous compartments has been erected, with each compartment named.

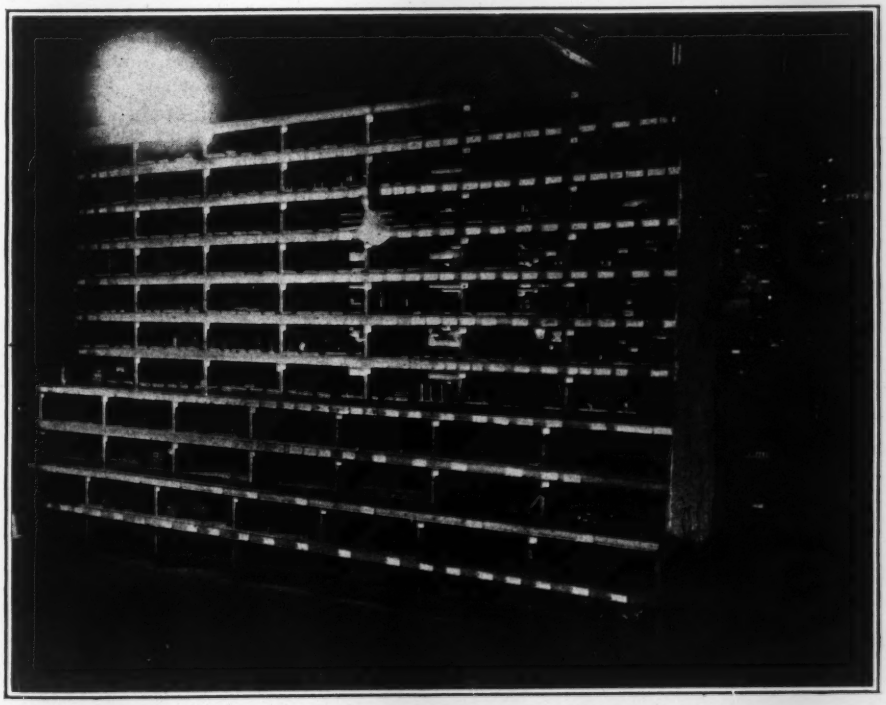


FIG. 7—RACKS IN STOREHOUSE FOR SMALL PARTS
Small items are placed in compartments in tin trays for easy inventory.

Storehouse Methods—The accumulated count method of handling items reaches its maximum usefulness in the storehouse, where there are some 2,380 items inventoried. These are classed into six subdivisions with racks and inventory books to match as follows: (1) Auto supplies, 750 items, mostly parts for Model T Fords and arranged in accordance with the Ford catalog numbers; (2) small pipe fittings, 300 items, arranged according to sizes; (3) fire hydrant parts, 140 items, arranged according to make of hydrant, with the heavier

FIG. 9—RACK FOR 1,000 PICKS, HANDLE RACK IN REAR

parts in lower, larger spaces; (4) valve parts, 160 items, same arrangement as for hydrants; (5) rivets, bolts, nuts, washers, cap screws and set screws, 720 items, arranged in accordance of size; (6) miscellaneous, 310 items, arranged according to convenience—that is, to fit the compartments.

Racks made from 1¼-in. lumber cut from staves from old wood pipe are 9 ft. high and usually have seven compartments 22 in. wide lengthwise on each of the shelves. The bottom compartment on the floor is 11 in. high but not ordinarily used. The second one is 10 in. high and 4½ ft. wide. The next two are set back to give an open shelf space and are covered to a width of 3 ft. 8 in. These spaces and all the remainder are 9 in. high. The next seven are 2 ft. wide. The top is not used. The cross-sections of all the racks are the same in general with larger compartments in certain cases for bulkier pieces, conservation of space always being a consideration.

Labels, about 1½x3¼ in. in general, are placed in tin holders made in the shop from scrap tin left over from making the tin trays. The holders are formed over a piece of sheet metal, about ¼ in. bent over on two sides and one end to retain the cardboard label. One end is left open to permit slipping in the label, which is pinched and kept from slipping out by a small punch in the upper right-hand corner of the folded part. Two shoe tacks secure the label holder to the front of the compartment directly below the tray whose contents it describes. For narrow trays short holders and labels are provided.

Trays are used to hold the smaller items such as rivets, bolts, nuts, washers, screws, small pipe fittings, brass fittings and small auto parts. If more than one trayful is maintained, the trays are stacked with the number or pounds marked cumulatively on each tray, the higher numbers, of course, being on top. A No. 14 gage tin was first used, but it was soon found to be too flimsy and No. 12 was finally adopted as making a more serviceable tray. Two types are used. One is ½ in. deep with the corners notched before the ½-in. sides were bent up. The other is 1½ in. deep with corners soldered. The length of all trays is 12 in., as they shove in from opposite sides of the 24-in. shelf. The width was made to order but in general made in even multiples to fit the compartment width and thus conserve space. Thus, for rivets, nuts, bolts and washers, the width is 5 in., permitting four to slide into a 22-in. compartment with sufficient clearance for handling without disturbing adjacent trays. These trays were made in the shops at a small fraction of the cost they could have been purchased made up.

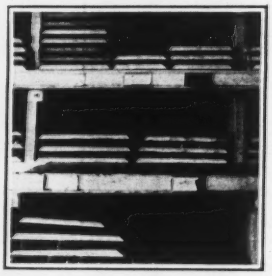


FIG. 10—BOLTS IN TRAYS WITH CUMULATIVE COUNTS ON TOP

Item labels in tin retainers are open at right end for insertion. Compartment numbers at upper right hand.

Miscellaneous Materials are kept in another portion of the storehouse. Lead is stacked up in grillage form, four pigs in each layer, thus easily counted. Waste, wiping rags, yarn, fireclay, lime and such bulk stuff is piled. Lead pipe coils are lined up at the back of a room with the floor toward the door marked off so that the proper lengths can be measured off quickly.

A novel pick rack consists of two upright 3½x8-in. timbers set about 8 ft. apart and provided with ½-in. hooks set 2 in. apart upon which 2x2-in. wood strips are laid successively after being loaded with picks. The back 2x2-in. strip is nailed to the 3½x8-in. upright, since one side of the pick can be easily inserted. Each strip holds 35 picks, determined by the width of the eye so that counting is easy. The rack will hold 1,000 picks. Handles are cared for in a similar horizontal rack.

Shovels with D-handles are supported by the handle between two strips about 2 in. apart, the shovel handle being inserted from below, then turned.

Lanterns are set on wood trays with wood cleats, the whole tray being portable so that it can be lifted into its place in an equipment truck. To minimize theft,

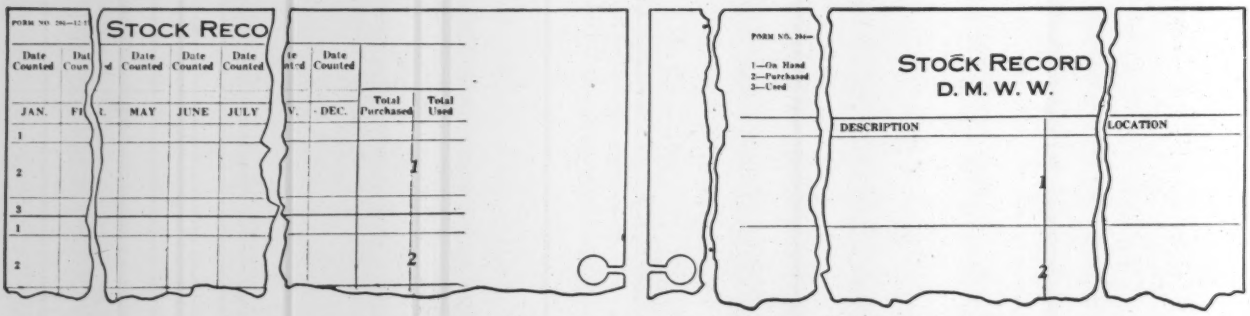


FIG. 11—STOCK RECORD LOOSE-LEAF SHEETS GIVING MONTHLY INVENTORY

On facing pages: Left-hand with spaces for entries under each item for (1) number on hand; (2) purchased; (3) used. Right-hand page gives description and location of the stock inventoried. The size of the left-hand page is approximately 11x14 in. and of the right-hand page approximately 9x14 in.

lanterns are ordered stamped with the words "Stolen From Denver Municipal Water Department."

For protection against deterioration from drying out, rubber gaskets are kept in a homemade humidor, consisting of four large compartments each containing a tray of water above which are nine 17x24-in. wood trays with wire bottoms.

Stock Records are kept in loose-leaf end-lock books with facing sheets to cover a year's entries, as reproduced herewith. The record is used only for inventory purposes and not to locate material, the storekeeper being so familiar with the stock arrangement that he can find articles directly on the shelves. However, to make the parts quickly found by others, an alphabetical card index of all items is now being made which will give position on the rack and in the record book.

The West Denver storage house, yards and shops are under the direct supervision of A. E. Voight, reporting to R. S. Sumner, general manager. D. D. Gross is chief engineer.

Bacteria Growing on Leather Packing Cause Errors in Sampling

By H. H. Gerstein

Assistant Sanitary Engineer in Charge, Division of Water Safety Control, Bureau of Engineering, City of Chicago

EXPERIENCE in Chicago has shown that samples of water collected from well pumps were at times contaminated by organisms growing on the pump leathers, which by ordinary bacterial tests could not be distinguished from B. coli.

The quality of the unchlorinated water in the tunnels between the intake cribs and the pumping stations is determined by bacterial analyses of samples of water collected from hand-operated well pumps, similar to those used by farmers, set in tunnel shafts with the suction opening at the elevation of the eye of the tunnel. Recently the analyses of samples collected from several of these pumps indicated pollution of sewage origin. Thorough and painstaking surveys of the tunnels and shafts sampled by these pumps failed to indicate any source of contamination of the water which would account for the degree of pollution shown by the samples.

To check the quality of the water in the tunnel with that obtained by sampling the pumps, duplicate samples were collected at various times, one from the pump in the regular way and the other by lowering deep sampling apparatus in the same shaft near the opening of the pump suction. Analyses of these samples showed that the water in the tunnels was of good quality, although the pump samples indicated sewage contamination. It became apparent, therefore, that some local condition caused the contamination of the samples from the pumps. Suspicion was directed at the leather packing on the plunger and suction valve in the pump cylinder as a possible medium on which the bacteria which were giving positive tests for pollution were thriving. These leathers were examined by Frank E. Greer, principal bacteriologist of the Chicago Health Department. He found that organisms were growing on them in great numbers which he confirmed as B. coli, using the American Public Health Association's standard methods. Several leathers which were placed in Mason jars with sterile water about a year ago have maintained a prolific growth of these organisms, the numbers at times reaching as high as several million per cubic centimeter. A similar condition was reported by Sir Alexander Houston, of London, in the twelfth report of research work by the Metropolitan Water Board. He obtained erroneous results from a sampling tap, which upon investigation was found to have a growth of bacillus of non-fecal origin on the leather washer in the tap. He called these "leather bacilli."

The Chicago problem was finally solved by replacement of the old-type pump cylinder with a specially designed metallically fitted pump cylinder. The working parts of this cylinder are metallic throughout, the valves being of the ball type. It contains no packing of any nature. After the installation of these cylinders the contamination of the samples due to local conditions in the pumps ceased, except at one pump. Investigation showed that the contamination in this case was caused by a leather packing in the top of the pump, which had been overlooked. This incident shows the importance of removing all packing from the pump in order to obtain samples for bacterial analyses which are representative of actual conditions.

There are indications that samples of water collected from fire hydrants may not represent true conditions in the main, due to contamination by bacteria growing on the leather seating valves of the hydrants.

Universal Water Metering Nears Completion in Jersey City

Survey Preceded Program—Installations About Half and Half by City and Owners, but All Costs Met by Owners

IN NOVEMBER, 1926, a program of installing meters on all unmetered water services in Jersey City, N. J., was started which will shortly place that city in the 100 per cent metered class. On July 1 about 33,000 of the 37,000 service connections, or some 90 per cent, were metered, compared with 38 per cent when the work was begun. This program was made possible by the passage of a city ordinance in December, 1925, requiring all water services to be metered "in order to conserve the city's water supply, to discourage waste and to charge all consumption at a uniform rate."

Survey Made—Before commencing this program, a survey was made of all premises in the city. Records were made of the fixtures on each water service inspected. The survey covered the entire city and was made primarily to determine the number of unmetered services. In many instances, however, illegal use of water was found as well as considerable leakage and waste. Abandoned water services and instances of more than one service supplying single premises were frequently found. Maps were made from the survey and the property was divided into sections with 25-ft. frontages. To each of these sections was assigned a serial number which was also the water service number. These total 55,000, including vacant lots. Block plans showing the serial numbers assigned to vacant or occupied 25-ft. lots were prepared. A set of these plans is kept on file at the office of the bureau of water.

Notices were sent to owners of premises having unmetered water services in order according to the serial numbers assigned, giving the owner 30 days in which to

install a meter. If the first notice was not complied with, a second was sent allowing the owner fifteen days additional time. Upon the expiration of this period, if a reasonable excuse for delay had not been given, the bureau would proceed with the installation of the meter. The actual cost of material and labor is the only charge made by the bureau, which charge accompanies the water bill sent at the next regular billing period. In case of failure to pay the cost of installing a meter the bill becomes a lien on the property after two years and the amount due is collected through tax sales.

Due to the fact that a large number of owners did not comply with the notice and install meters privately, the bureau added about 30 licensed plumbers to its payroll to carry on this work. These plumbers, working under union rules, install on an average of 1½ meters a day. If the owner installs his own meter, he hires a licensed plumber to do the work. The plumber obtains a permit, and when ready to have the meter set he notifies the bureau and the meter assigned to that service is promptly furnished and set by the bureau. In this way all meters are in the hands of the bureau from the time of testing until they are installed on the service. Approximately the same number of meters have been installed by the bureau as by the owners.

All meters are tested and approved by the water bureau before being installed. The testing of these meters is carried on at the bureau's meter-testing shop. New meters are placed on the testing bench and the standard A.W.W.A. test for cold-water meters is made. The meter is then sealed and given a city number corresponding to the serial numbers assigned to each 25-ft. plot. This number is stamped on the inside of the register box cover as well as on a brass plate soldered to the meter body.

Particulars as to the installation and control of service connections and additional information on meter practice follow:

Services—Material for services up to less than 2 in. may be of brass, of lead or of lead-lined galvanized-iron pipe; larger sizes may be of the latter material, brass or cast iron. Services must be laid in a straight line from the street main to the property line (which is the same as the building line), at right angles to the main, and must be at least 4 ft. below street grade; or, where this is not possible, they must be protected against freezing or other injury. Connections are made only by employees of the bureau of water, at a charge to the owner of the premises depending upon the size of the service. All services must be provided with a valve located at the curb; inverted T-type stop cocks may be used for services 1 in. and smaller. Within 2 ft. after its entry into a building each service must be provided with a second valve or stop cock so located as to be readily accessible. Whenever an improvement ordinance directs that a service line shall be constructed from the main to the curb for vacant property, a stop cock shall be placed at the curb.

Meters—The water bureau furnishes and sets all meters up to and including 1 in. in diameter, at the expense of the owner. Larger meters require the approval of the water bureau before being installed and are subject to tests by the bureau. The smaller meters are set with meter couplings and stop cocks on either side of the meter, together with a waste cock which is placed so as to drain the entire system which the meter supplies. A bypass connection with a 2-in. testing valve is required on all meter settings 3 in. and over in size. The owner of the premises where a meter is installed is held responsible for its care and protection from freezing or injury or interference by any person. It is the practice of the bureau to seal the meter register so that it may not be tampered with. In place of using a wire seal, the register is sealed by means of coating the register box screws with a sealing compound and imprinting the compound with a stamp.

On account of the owner being responsible for the repair and condition of the meter, the bureau does not make a practice of sealing the meter in the service line. Occasionally meters are examined where the consumption seems unusually low to see whether a meter has been reversed or not. This can easily be ascertained from the condition of the gear train arm, which would show wear on both sides if the meter had been operated backward. Meters are tested upon application and payment of a testing charge of $2 for meters up to and including 1 in. in size. For larger meters, the charge for testing is the actual cost of the work.

Owner's or Occupant's Responsibility—When leaks are found in a service pipe, notice is served upon the owner or occupant to make the necessary repairs, and if the notice is not complied with, the department shuts off the service at the expense of the owner. A charge of $1 for turning on and off the water is made.

Water service may be discontinued by the city if the water is used for any other property or purpose than that described in the application; for willfully wasting water through improper or imperfect pipes or fixtures; for failing to maintain in good order the connections, service pipes or fixtures; for molesting or tampering with any service pipes, meters, stop cock or seal; or neglecting to make advance payment or for non-payment for water service or any other charges accruing under the application; for refusing reasonable access to property for the purpose of inspecting or reading, caring for or removing meters; and for making any additions or alterations whatever in the piping supplied by the service without first having received a permit therefor.

Meter Rates—The charge for metered water is 90c. per 1,000 cu.ft., regardless of the purpose for which it is used or the volume registered. Bills to commercial or industrial consumers are payable monthly, while water consumed for domestic purposes is billed and payable quarterly on the first day of January, April, July and October. Each meter is charged and billed separately. Interest at 10 per cent per annum is added to all meter bills if not paid within 30 days from the date due.

The bureau is a part of the Department of Streets and Public Improvements, of which Michael I. Fagen, one of the five city commissioners, is director. The metering program is in charge of A. B. Mauzy, water conservator.

Mexico Planning Irrigation Projects

A report of the U. S. Department of Commerce states that the Mexican government is contemplating extensive reclamation projects in the western part of Mexico. Four projects are being considered: (1) An irrigation canal from Tesia to Mustabampo in the Mayo Valley, at an estimated cost of about $500,000. (2) The extension of privately owned irrigation areas in the Yaqui Valley, recently acquired by the government from the American owner. (3) A similar project for the Mayo Valley. (4) The construction of a storage dam in the Sonora River.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Fly Spray Used at Garbage-Disposal Plant

ON THE hog farm operated by the Fontana Farms Company, where 398 tons of Los Angeles garbage is daily fed to hogs, the fly nuisance is kept down by the use of a horse-drawn spraying unit operated by two men. The outfit consists of a 150-gal. tank mounted on a small truck with a power-driven compressor that makes it possible to deliver spray from a nozzle under a pressure

FLY-SPRAY OUTFIT IN ACTION

of 150 lb. per sq.in. The mixture is made up with a stove distillate base in the following proportions: To a 48-gal. barrel of distillate is added 4 lb. of Cresole (U.S.P.) and 4 lb. of oil of myrbane. Care is taken not to get any of the spray on livestock, because of the burning qualities of the myrbane. The spray is used, as far as possible, in the early morning and in the evening, when the flies have clustered and are least active.

Large Wood-Frame Structure Lowered 36 Ft. to New Street Level

A REGRADING job near the foot of First St. in the Los Angeles harbor district at San Pedro, Calif., involved the complete removal of a knoll on which the old Hotel San Pedro, a wood-frame structure, had stood for many years at an elevation of 36 ft. above the present street grade. The removal of the knoll was necessary to make way for additional railroad tracks and wider streets along the waterfront. This particular item in the regrading project involved moving about 22,000 cu.yd. of material which was firm enough to stand on a vertical slope but which could, nevertheless, be excavated by power shovel.

Having excavated a vertical face in the hill close to the old building, a timber crib was erected adjoining this face and the structure was moved horizontally onto the cribbing. Once supported on the cribbing, the lowering was accomplished by the usual jacking method. On reaching the present street grade, the structure was moved about 150 ft. to a new location.

C. R. Butterfield was the grading contractor, and the building was removed by the Star House Movers, Inc., of Long Beach, Calif. The preceding description is based upon data, together with photographs, sent by G. F. Nicholson, harbor engineer, Los Angeles.

Old Cofferdam Removed by Power Scraper Bucket

IN PLACING the foundation for the power house built in connection with the newly constructed dam of the Northern States Power Company at Chippewa Falls, Wis., it was necessary to construct a cofferdam across

FIG. 1—POWER SCRAPER BUCKET INSTALLATION REMOVING OLD COFFERDAM FROM RIVER

part of the channel. After completion of the work it was required to open the channel in order to comply with a government order and to lower the tailwater discharge from the turbines. The cofferdam was composed of sand, gravel and large boulders. A steam shovel was

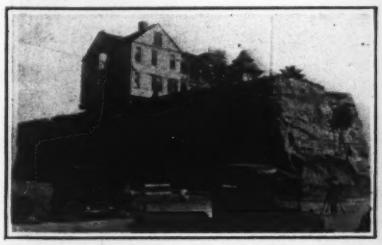


FIG. 1—HOTEL IN ORIGINAL LOCATION ON TOP OF KNOLL

FIG. 2—STRUCTURE MOVED TO CRIBBING ERECTED ON STREET

FIG. 3—LOWERING HALF COMPLETED. EXCAVATION UNDER WAY

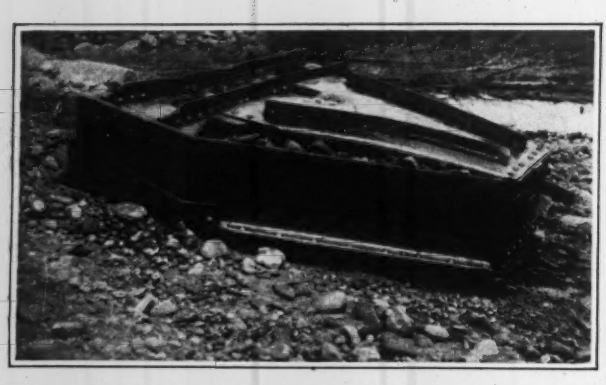


FIG. 2—HEAVY-DUTY POWER SCRAPER BUCKET WITH LID PREVENTED MATERIAL FROM WASHING AWAY

used to remove some of the cofferdam above water, but it was felt that this method of excavation would be costly for the underwater portion, since the plant would have to be shut down and the water diverted through the dam gates. One of the company's engineers suggested the use of a power scraper. The type bucket adopted, a Garst model, is shown in one of the accompanying illustrations. It necessarily was of heavy construction to withstand the battering from the boulders and the use of the lid prevented the material from being washed out of the bucket as it was being dragged to the shore. The material removed totaled about 30,000 cu.yd. The bucket used had a 2-yd. capacity.

Barges Remove Spoil at Chicago Building Sites

MOTOR truck handling and barge transportation of spoil is being employed on two large construction jobs in Chicago. In sinking the wells or caissons for the foundation piers of the Daily News Building, special methods had to be employed in removing the spoil, as this is an "air-rights" building to be erected over the north approach of the Chicago Union Station, so that many of the wells come between the tracks, while traffic must be interfered with as little as possible.

From Job and Office

Hints That Cut Cost and Time

A timber trestle has been erected, U-shaped in plan, with one leg along Canal St. and the other along the dock wall, connected by a shorter stretch across the tracks. Spurs are extended from the main trestle to the locations of the wells. Material is hoisted to the level of the trestle and loaded into small three-wheel motor dump trucks with V-shaped bodies. These trucks run to the river-front trestle and dump the material into large hopper barges, which are towed out to Lake Michigan and discharged in deep water. The loading of a barge is shown in the accompanying view. Steam pipes were laid along the steel-lined dumping apron to prevent freezing of the clay and dirt.

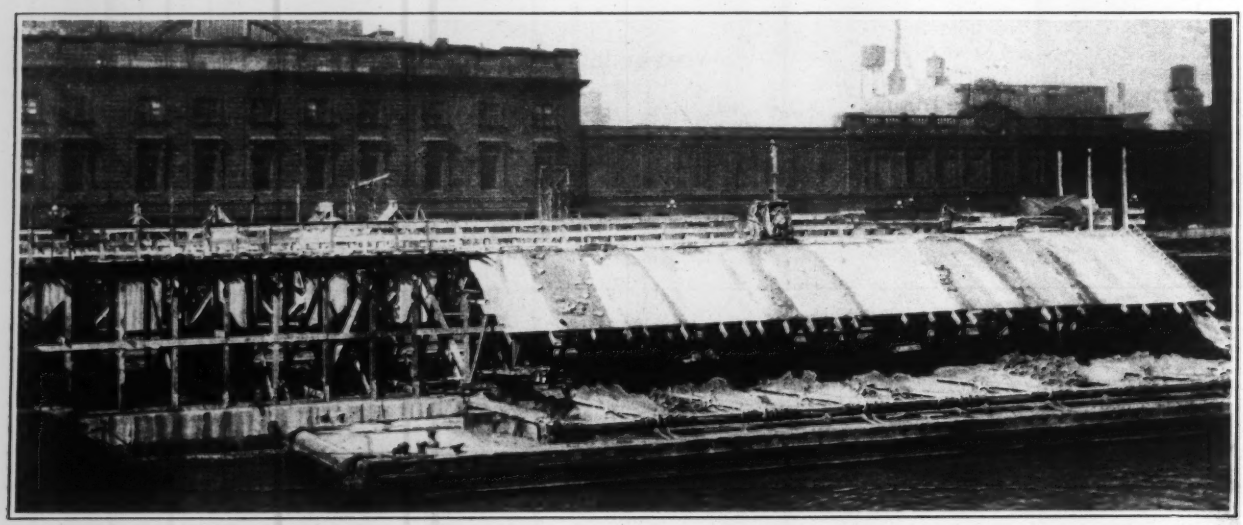
On the opposite side of the river some large buildings have been removed to clear a site for the new opera house. Here similar small dump trucks were used on the several floors to deliver the wreckage to chutes discharging into the hopper barges. After the buildings had been removed to the basement level, the site was excavated almost to water level by means of steam shovels, the spoil being delivered to the barges by ordinary motor trucks, by portable belt conveyors and directly by the shovels.

The John Griffiths & Son Company has the contract for the substructure of the Daily News Building, but the removal of spoil at both the above sites was handled by the W. J. Newman Company.

Bolt With Self-Tightening Check Nut Useful on Construction Job

By Charles Martin
Lewisburg, Pa.

A BOLT with a self-tightening check nut, as shown in the accompanying illustration, can be used in many places around construction jobs, such as for anchoring equipment, setting machinery and bolting temporary



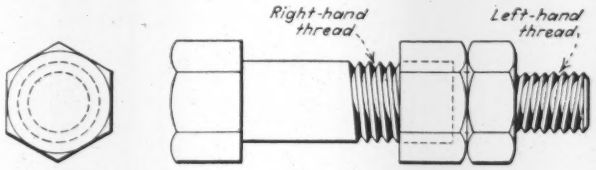
DUMPING MUCK INTO HOPPER BARGE

The tracks of the approach to the Chicago Union Station are at the level of the dock wall. The trestle is at street level. Tracks in the Chicago & Northwestern station are above street level.

From Job and Office

For Contractor and Engineer

structures and plants subject to excessive vibration. The bolt can be made in any machine shop by turning down part of the outside threaded end of a standard bolt to a smaller diameter and threading the smaller portion with a left-hand thread. Nuts tapped with left-hand



BOLT WITH SELF-TIGHTENING CHECK NUT

threads can be made at the shop or purchased from the larger dealers. It is obvious that using left- and right-hand threaded nuts as shown they will be self-locking.

Chart for Calculating Material Cost Per Cubic Yard of Concrete

By Charles M. Bull
Mobile, Ala.

THE accompanying chart offers a graphical determination of the cost of materials in a cubic yard of concrete of various mixes and with a variety of individual material prices. Its use is as follows:

In the problems shown, the price of cement is assumed at $2.30 per barrel, sand at $2.25 per cubic yard, and gravel at $2.60 per cubic yard. Required the material cost of a cubic yard of 1:2:4 concrete. Start at 2.30 in the 1:2:4 column at the right side of the diagram, follow horizontally to the left until intersecting the 2.25 diagonal line representing sand, then follow vertically until the 2.60 line diagonal representing gravel is intersected. From this point follow horizontally to the left to the 1:2:4 column on that side of the diagram. The intersection with this column gives the material cost per unit yard of 1:2:4 concrete, which in this case is $6.32. Similarly, using the same material prices, we find a cubic yard of 1:2½:5 concrete to cost $6.05.

Explosives Used in Ship Repair

THAT high explosives can be used to advantage in very restricted space has been demonstrated in connection with the repair of the U. S. S. "Colorado." After the recent collision emergency repairs were made by pouring 30 cu.yd. of concrete into the opening. When the battleship was docked attempts were made to remove this concrete by means of pneumatic paving breakers, but the progress was so slow that the ship's schedule would have been seriously delayed. It was decided, therefore, to try to remove this concrete by means of explosives. Small charges of 30 per cent dynamite were used, each hole containing one-half stick. A maximum of three holes were fired at a time. The concrete was completely broken up in 2½ hours. It was noticeable that none of the surrounding structural work was damaged to the slightest extent, and the shock transmitted to the ship was practically negligible. The work was carried on at the Puget Sound Navy Yard under the direction of Capt. E. R. Gayler, of the Civil Engineer Corps of the Navy, with Lieut. Comdr. C. H. Cotter in charge.

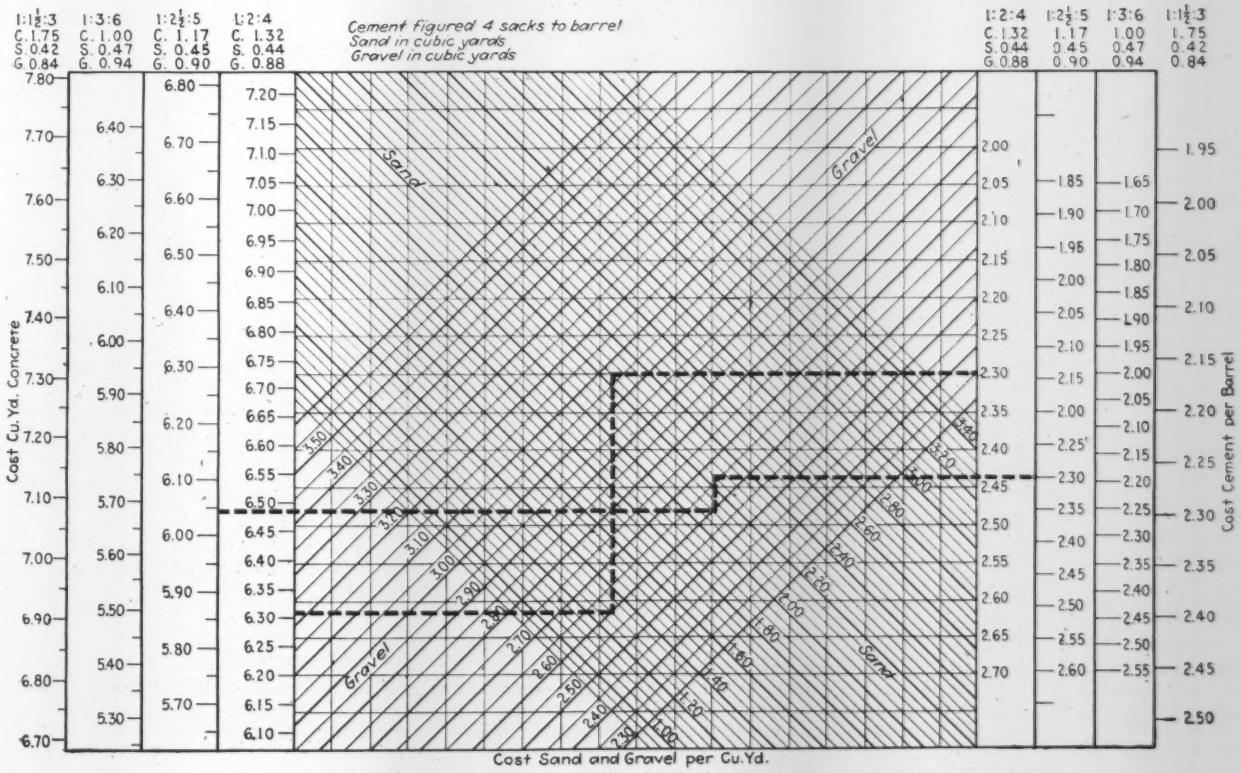

1:1½:3 C. 1.75 S. 0.42 G. 0.84
1:3:6 C. 1.00 S. 0.47 G. 0.94
1:2½:5 C. 1.17 S. 0.45 G. 0.90
1:2:4 C. 1.32 S. 0.44 G. 0.88
Cement figured 4 sacks to barrel
Sand in cubic yards
Gravel in cubic yards
1:2:4 C. 1.32 S. 0.44 G. 0.88
1:2½:5 1.17 0.45 0.90
1:3:6 1.00 0.47 0.94
1:1½:3 1.75 0.42 0.84
Sand
Gravel
Cost Cu. Yd. Concrete
Cost Cement per Barrel
Cost Sand and Gravel per Cu. Yd.

CHART FOR CALCULATING MATERIAL COST OF CONCRETE PER CUBIC YARD

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Dangerous Highway Danger Signs

Sir—This letter is inspired by the editorial "Red for Danger" in *Engineering News-Record*, Aug. 9, 1928, p. 194. To one who for years has been engaged in railroading the indiscriminate use of red lights, or colored flashing lights, along highways seems to incur such foolish risks and to lend so to the distraction of stranger drivers that control should be at once vested in the traffic bureaus of state highway departments by state legislation generally. Signboards for advertising which obscure visibility should be likewise controlled. Many states which now have all too few directing signs have these few almost submerged by advertising signs constantly mistaken for directing signs; the size, shape and color of the advertising signs are often identical with the directing signs.

State legislatures should also consider the feasibility of legislation covering the movement of slow-moving trucks. Trains of these operated by one company habitually move with too small a spacing between units.

Another matter might well come under the supervision of traffic bureaus. This is the establishment of traffic lights at points where their use unnecessarily halts large volumes of traffic. If the total traffic at a point does not amount to a certain volume, or if the cross-traffic does not amount to a fairly large percentage of the main traffic, no light should be operated. The establishment of lights should not be the whim of local agencies.

Columbus, Ohio,
Aug. 21, 1928.

V. A. EBERLY.

* * *

The Question of Veneered Concrete

Sir—In reference to the editorial on "The Question of Veneered Concrete" in *Engineering News-Record* Aug. 3, 1928, p. *267*: While I agree with your very idealistic views that "there should be no excuse, except an esthetic one, for covering concrete with stone or brick, or any other material, and even the esthetics of the practice is questionable," it would nevertheless appear that our hopes and aspirations are at present curtailed and circumscribed by our uncertain knowledge of both the materials and the workmanship of concrete.

In 1909, in constructing Dry Dock No. 4 at the Brooklyn navy yard it was decided to face the concrete side walls and altars with vitrified paving brick. The suggestion, I think, came to me first from Capt. Leonard M. Cox, civil engineer, U. S. Navy, now retired. The practice up to that time had been to face the walls of such structures, especially when built in climates subject to frost action, with granite or other stone masonry. There were several European examples of structures faced with brick and one American example—namely, the dry dock at Halifax, N. S.

Dry Dock No. 4 at Brooklyn was consequently built with vitrified brick laid up in enriched mortar to which an integral waterproofing compound was added. The brick wall was constructed with counterforts or rear pilasters at intervals and had, in addition to this bonding, metal ties inserted between brick courses to anchor the facing to the concrete backing. The brickwork served as a form, as was the case in the brick-face, concrete-arch dam described.

At the dry dock every effort was made to secure a dense, impervious facing, it being the object of this construction to find a substitute less expensive than the granite masonry facing ordinarily used and at the same time to avoid depending on exposed concrete, which material, our experience up to that time indicated, would deteriorate and disintegrate. Even at that time it was generally accepted as a fact that concrete structures immersed in salt water or subject to a considerable hydrostatic head of salt water, or even of fresh water, during the course of years were unable to preclude seepage through the concrete mass, with the result that chemical changes took place. The view was then firmly fixed that the sulphates of sea water were inimical to the integrity of concrete. Our specifications at that time insisted on the use of a cement that would withstand the action of salt water, and that would meet Vicat's formula—namely, $\frac{\text{Silica-alumina}}{\text{Lime-magnesia}}$ must be greater than 1 to avoid decomposition in sulphate solutions.

In more recent practice much of this old knowledge has been overlooked or forgotten. We have been engrossed in the so-called "design" of concrete aggregates and the grading of these and so won over to the excess use of cement in concrete that we have entirely forgotten or have overlooked the instability of the cement and cement paste which binds the mass of aggregates and makes these loose materials an artificial stone.

Recently, especially since the war, the manufacturer of special cements has again directed our attention to our lack of a complete understanding of the chemistry of cements. Undoubtedly the *Engineering News-Record* is fully alive to this situation, as evidenced by the space allotted in the issues of June 7 and June 14, 1928, to the very interesting and enlightening articles on modern cements by P. H. Bates of the U. S. Bureau of Standards. Engineers employing concrete not alone in sea water but for dams impounding fresh water would do well to read carefully a paper with its discussion entitled "The Disintegration of Cement in Sea Water," by William G. Atwood and A. A. Johnson, presented at the meeting of the American Society of Civil Engineers of June 13, 1923.

This is all preliminary to the fact that within the last year or so the Navy Department on finding the concrete work in Dry Dock No. 4, Brooklyn navy yard, badly disintegrated, has undertaken the repair of the structure at considerable expense. The vitrified brick, while doing some good, did not entirely prevent the seepage of water through the concrete walls with the consequent deterioration of the concrete, the water in this case being fresh groundwater acid in its reaction. Apparently a similar experience has been had at Halifax, Mr. Brydone-Jack, in charge of this dock, having informed me of this several years ago.

You have stated in concluding your editorial: "Is it then the engineer's mission to house in all his exposed concrete in the fear that some of it may scale and spall, or is it his mission rather so to perfect his design and control of concrete mixtures and so to devise their placing and curing that all concrete structures are as resistant and enduring as many of them have proved to be?" It is an engineer's mission to do the best he can with the materials available. Modern concrete and modern cements still leave much to be desired. We all know that they are not enduring for all time. Much harm has been done and is being done by giving the impression to laymen and owners that modern concrete is permanent and will last through the ages, the harm taking the form of great surprise and a lack of confidence in engineers and constructors when, after a short period of years, the concrete stuctures show crazing, cracks, spalling and the beginning of disintegration. Mr. Bates and the *Engineering News-Record* are to be congratulated on the timely articles in the two June issues of this year and the engineering profession is much indebted to Messrs. Atwater and Johnson for their paper of 1923, but apparently we still have to go a long way before we truthfully and with confidence shall be able to state that we have so perfected the design and control of concrete mixtures that they are so resistant and enduring under all conditions as not to require brick veneer or masonry protection.

F. R. HARRIS.

New York, N. Y.,
Aug. 28, 1928

Sir—In reading over the editorial entitled "The Question of Veneered Concrete," the writer was impressed with its contents until the concluding sentence was reached, which reads as follows: "There should be no excuse, except an esthetic one, for covering concrete with stone or brick, or

any other material, and even the esthetics of the practice is questionable."

In the question of the covering of the Caneadea dam I can see every excuse for resorting to every possible means of protection for this structure. Failures of dams have been numerous and I think it an obligation of the engineering profession to devise every means of protection against failure and catastrophe.

I am fully convinced that a covering of vitrified paving brick in a well-planned design is not alone a protection but also a factor in the strengthening of the structure.

I believe that the statement above quoted in the last sentence of your editorial is somewhat too strong and not in keeping with the arguments preceding it and believe that with the high standard of your publication such a statement should not be repeated. I believe it is not your intention to discredit any material in this manner.

Columbus, Ohio,
Aug. 29, 1928.

H. D. BRUNING.
Consulting Engineer.

Sir—I am wondering if you realize that your editorial on "The Question of Veneered Concrete" shows a prejudice on your part for concrete and against brick. You could very rightly query why back up brick with concrete. Brick is amply able to carry building loads and withstand all pressure. Concrete is not essential in building walls and is an economic material to use only as supporting columns around steel.

Columbus, Ohio,
Aug. 28, 1928.

ROSS C. PURDY.
General Secretary,
American Ceramic Society

* * *

Bad Building Habits

Sir—It is not often that the careful reader finds such an unusual lapse in your editorial columns as occurs in the *Engineering News-Record*, Aug. 9, p. 193, under the heading "Bad Building Habits."

To make an attack upon the creative operations of the construction industry on the basis of the temporary inconvenience which they occasionally cause is to take the astounding, naïve position of failing to understand that no undertaking of creation is devoid of temporary dislocation.

Every thoughtful engineer and builder and layman will take sharp issue with your statement that the "builder steps on everyone's toes" and that "his work is noisy and dirty, so much so that quite apart from higher esthetics it is a common nuisance." The fertilization of fields from which mankind's sustenance comes is quite obviously a dirtier process than building operations and unquestionably less fragrant. Yet as great a philosopher as Tolstoy has rhapsodized upon the smell of manure in the fields and the implication of its ultimate purpose. To sniff at these vital processes is to show an attitude toward life from which no resultant betterment can develop.

Your editorial goes on to state that "the builder boldly preempts public sidewalks and streets with his offices and storage sheds" for material, equipment, etc., and that this is unnecessary trespass on public space and that "in part it merely simplifies and cheapens the builder's operations"; also, "it is the outgrowth of slipshod habits and poor system." You go on to state that "though builders can hardly be unaware of the change, their practices continue as they always were."

These statements are (in this part of the country at any rate) not understandable, since by municipal rules and authority vested in such bodies as the city engineering department and the board of public works no public space in the street or sidewalk can be used without special written permission based on an investigation of the conditions by the above-named authorities.

As long as people live in great cities with dense traffic and concentration of high buildings in restricted areas, certain inconveniences are an integral part of their lives. They are the price we pay for what we deem civilization. Those caused by building operations certainly are minor and not to be compared in detrimental consequences to many others. It is a commonplace thing to see that so far from infringing on public convenience a building operation in a city often provides a fascinating, interesting and instructive sight for thousands of spectators. When one contemplates the poisoning of the atmosphere by the cumulative effect of thousands of automobiles, the nerve-racking effects of driving an automobile in crowded metropolitan areas, or the grinding, pounding noise of trolley car operation, which could be largely eliminated, the writer ventures that it will be generally conceded that the criticism of building practices in your article is not well founded.

One of the most important considerations often governing the entire situation is not mentioned at all in your columns—namely, safety to the same public which is spoken of as being inconvenienced. In the sinking of a deep foundation with the possibility of bank collapse it becomes of paramount importance to keep the public away from the immediate work to prevent the possibility of serious accidents. The necessary protection—walks, canopies, insurance and other costs which the builder incurs for this significant cause—is sufficient indication of something else than selfish interest in these practices.

Finally, building practices of this type cannot be a matter of industrial self-regulation, as you suggest, since they affect the public vitally from the standpoints of convenience and safety. Necessarily, therefore, they require the ultimate authority to control these practices to rest in the hands of public bodies sufficiently removed from specific interest in any project to act impartially and in accordance with the highest interest of the public, bearing in mind the requirements and the hardships of construction and the ultimate convenience to the public of the finished construction, whether it be building, bridge, road, dock, tunnel or dam!

Los Angeles, Calif.,
Aug 31, 1928.

ZARA WITKIN,
Chief Engineer,
Herbert M. Baruch Corporation.

* * *

Green for Exit Lights

Sir—The Aug. 9 issue carries an editorial on p. 194 of particular interest concerning discussion of the confusing uses of red as a color signal, and its importance as a danger marker. There could be no criticism of the article, but the thought occurs to me that there is another confusion in the use of red lights which has almost equal importance to your discussion.

Ira Woolson, when drafting the building code for the National Board of Fire Underwriters in 1912-13, took the lead and responsibility for his recommendation of green for lights used as markers for avenues of egress from theaters and similar places of public assembly. He explained the radical suggestion with this note: "It has been customary to designate an exit by a red light, but state and national safety organizations adopted green as the standard color to indicate safety and red to signify danger. It is therefore consistent that exit signs, which betoken safety, should be marked by green lights."

The writer is a member of the building exits code committee. Its report, as printed in 1927 (constituting a tentative American Engineering Standard), in section 12 of the code, in its provision for lighting and signs for exit ways, bears the following advice: "The green used for transparent material shall be of the hue known as signal green or admiralty green: Note: Green is prescribed for exit signs in conformity with the color scheme adopted for traffic signals. Except where otherwise required by law or other compelling circumstances, the light source should give a white light for the better illumination of the sign and the vicinity of the exit door."

What could be more confusing than for the occupants of a theater, in fleeing from a smoke-filled auditorium via a red exit light, to see, immediately on the sidewalk or in the street, an obstruction marked by red lanterns as a danger signal? In my activity in assisting the development of sound and judicious legislation reflecting control of building construction, I find this inconsistency almost nation wide and therefore hard to secure the desired change for simplification. The city of Columbus and a few smaller communities of the State of Ohio are the only locations at the present time that I know of where green exit lights are required.

New York City,
Aug. 21, 1928.

FRANK H. ALCOTT,
Structural Engineer,
National Lumber Manufacturers Association.

News of the Week

Program Announced for Montreal Water-Works Meeting

A large number of interesting papers are announced for presentation before the annual convention of the New England Water Works Association at Montreal, Sept. 18-21. Some of the questions to be discussed are: "Protection of Catchment Areas," by John F. Skinner, assistant city engineer, Rochester, N. Y.; "Unusual Methods of Water Purification," by M. E. Flentje, superintendent of purification, Community Water Service Company, New York City; "Recent Developments in Water Purification," by Wellington Donaldson, of Fuller & McClintock, New York City; "The New Water Purification Works at Greenwich, Conn.," by E. Sherman Chase, of Metcalf & Eddy, Boston, Mass.; "The Extension of the Works of the Greenwich Water Company, Greenwich, Conn.," by Dana M. Wood, of Stone & Webster, Boston, Mass.; "The McTavish St. Pumping Station," by Charles J. DesBaillets, chief engineer, Montreal Water Board, Montreal; "The Montreal Filtration Works," by Frederick E. Field, division engineer, Montreal Water Board; and "Factors in the Design of Distribution Systems," by V. Bernard Siems, vice-president and chief engineer, Detwiler & Co., Inc., New York City. Visits will be made to the plant of the Consolidated Pipe Company and to the Montreal water-purification plant.

The presentation of reports by a number of committees is expected to be made.

Call for Bids on $25,000,000 San Gabriel Dam

On Sept. 6 the Los Angeles County Flood-Control District announced that bids would be opened at 10 a.m., Nov. 14, for the construction of the flood-control dam to be built at the Forks site in San Gabriel Canyon. Plans and specifications, to be available within a week, it was announced, will provide for the construction of the "high dam," a name that originated during litigation over the question of whether the structure should be of a height to store 180,000 acre-ft. as advised in the Marx-Paul-Fowler report (*Engineering News-Record*, April 7, 1927, p. 570) or 240,000 acre-ft. as originally contemplated (*Engineering News-Record*, June 3, 1926, p. 890).

On the basis now specified the project involves 1,200,000 cu.yd. of excavation, 3,800,000 cu.yd. of concrete and 2,400 tons of steel.

Plans will be issued on payment of $50 per set.

Equipment Makers Meet to Discuss Credit Practices

Plans Made to Standardize Credit Terms at Chicago Meeting Held by A.G.C.

The whole construction industry is suffering from loose-credit practices, it was contended at meetings held by the Associated General Contractors in conjunction with various groups of equipment manufacturers in Chicago Sept. 4 and 5. The conference indicated how unsound and discriminating practices of unduly extending time payments and requiring little or nothing as down payment are penalizing the responsible contractor and are accountable for numerous low bids which are said to have demoralized the industry in many places.

Equipment manufacturers have been classified in ten groups by the A.G.C. for the purpose of working out reasonable credit terms agreeable to all. Two of the groups have met previously and now have terms under consideration. These are the mixer manufacturers, who met June 27, and the shovel and excavator makers, who convened Aug. 8.

From a survey of the manufacturers' present terms these results are noted:

First, as to down payments; less than 25 per cent cash is required by one firm and no one recommended so low a figure; 34 firms get 25 per cent cash and 27 recommended that this figure be the standard; 31 require 33⅓ per cent cash and 40 recommended it; 5 stated cash demanded depended on the credit of buyer and 4 recommended that procedure.

As to extension of payments the following table shows a wide range of practice:

No. of Mfrs.	Ave. Time of Payment, Months	No. of Mfrs. Who Recommend This Time
9	4	7
17	3	24
13	4	9
18	6	16
3	8	2
0	9	7
5	10	1
1	12	2
2	15	1
0	18	1
3	depending on buyer	1

It is especially to be noted that the average time is given, not the maximum, which ran in the answers approximately double the average time. It is this occasional long-time extension that quite often has caused the trouble.

Time suggested for deferred payments ranged from two months for saw rigs and electrical tools to nine months for shovels, cranes, ditchers, draglines, trenchers, dredges, rollers, tractors and crushers. For all other equipment a period of either three or four months was recommended, with a minimum of one-third cash.

These figures were submitted only as starting points from which the manufacturers themselves can carry on further study.

According to S. W. Williams, manager of the engineering construction division of the A.G.C., who is handling the conferences, the stabilization of credit is an obligation of those individually engaged in the manufacture and sale of equipment, the first step to be the standardization of credit terms. The function of the A.G.C. in these conferences is, according to Mr. Williams, to create a realization that the manufacturer, the distributor and the contractor each have contributed to the unfair trade practices in the industry, to encourage the acceptance of reasonable credit terms and to discourage the demand for unsound concessions.

Three Engineers Named to Water Power Committee

Three well-known engineers, all members of the American Society of Civil Engineers, have been appointed to a committee of sixteen members formed by the U. S. Chamber of Commerce to study national water-power policies. The new members are D. C. Henny, Portland, Ore.; George F. Swain, Cambridge, Mass.; and Harry F. Taylor, Washington, D. C.

Mississippi Contract Awarded

A contract for 1,100,000 cu.yd. of hydraulic landside levee enlargement in the parishes of Tensas and Point Coupee, Louisiana, has been awarded to the McWilliams Dredging Company, New Orleans, La., by the Mississippi River Commission. The company is moving a hydraulic dredge to the location of the work from St. Louis, Mo., and expects to begin actual operation within two weeks. The contract provides for completion by June 1, 1929.

Pumping Plant Drains 17,000 Acres of Arkansas Land

Virgin timber and farm land totaling 17,000 acres will be made available by a new $250,000 pumping station at Roseland, Ark. Overflow water from the lowlands will be pumped to a higher level by three pumps with a capacity of 50,000-gal. per minute, and then flow to the Little River and St. Francis River. The drainage project was carried out by the Mississippi County Drainage Commissioners, who are now offering the reclaimed land for sale. The pumping plant is 90 miles northwest of Memphis and 14 miles west of Blytheville, Ark.

Rondout Valley Rain Gages Show High Precipitation

More complete figures are now available on the heavy rainfall which caused the disastrous flood in the Rondout Valley described in last week's issue. Five gages were maintained by the New York City Department of Water Supply at intervals between Peekamoose, N. Y., near the head of the creek, and Kingston, N. Y., at its outlet into the Hudson. Of these five gages, one was completely destroyed by the flood. Records obtained from the others are given in the table below:

Location	Rainfall Aug. 26	Aug. 22–28	August
Peekamoose	5.71	8.52	14.34
Grahamsville	6.81	9.48	15.53
Lackawack	4.68	6.48	10.40
Kingston	1.75	5.07	9.64

A preliminary and unofficial estimate of the stream flow, based upon the height of the water over the dam at Honk Falls power station of the Central Hudson Gas & Electric Corporation, gives an estimated maximum runoff of 27,000 sec.-ft. from a watershed of approximately 110 square miles. This approximate runoff of 245 sec.-ft. per square mile compares very closely with the runoff from certain Vermont streams during the 1927 New England floods as given in *Engineering News-Record*, June 7, 1928, p. 890.

Course in Concrete Mixture Design to Be Given

A short course in the design and control of concrete mixtures is to be given at the University of Pennsylvania, Philadelphia, Pa., Sept. 18-21, under the sponsorship of the Portland Cement Association. The work will consist of eight three-hour sessions. Members of the association staff and specialists engaged in concrete construction or research work will give the lectures and demonstrations. An outline for an undergraduate course in designing and testing concrete will be presented. Several construction projects near Philadelphia will be visited on a field trip which is part of the course.

Brief News

GROUND BREAKING CEREMONIES for the new Kill van Kull bridge from Staten Island, New York, to Bayonne, N. J., will take place Sept. 18. Many prominent officials from New York and New Jersey will participate in the celebration. The bridge, to be built by the Port of New York Authority, will be one of the longest steel arches in the world, with a span of 1,600 ft.

HEARINGS ON THE APPLICATION of the Denver & Southwestern Railroad for authority to construct the long proposed Dotsero cutoff between Orestod on the Denver & Salt Lake and Dotsero on the Denver & Rio Grande Western in Colorado, will be held before the Interstate Commerce Commission by the Public Utilities Commission of Colorado at Denver on Sept. 18. The proposed cutoff, 42 miles long, would give a direct transcontinental route through Denver via the Moffat tunnel with a saving of 173 miles on the present route between Denver and Salt Lake.

BATES & ROGERS CONSTRUCTION COMPANY, of Chicago and Cleveland, announces the opening of a New York office at 75 West St. Roy E. Ross, district manager, will be in charge of the new office.

THE STATE OF NEW MEXICO is constructing 15 miles of gravel-surfaced highways in the southern part of the Rio Grande Valley at a contract price of $236,694. On Sept. 19 the New Mexico Highway Department will open bids on six road and bridge projects totaling $350,000.

A BELT LINE RAILROAD which will reroute traffic around the city of Pontiac, Mich., has been started by the Grand Trunk Railway. The project will cost $800,900. Permission for the new line was granted by the Interstate Commerce Commission upon condition that work should start before Sept. 1, 1928, and be completed before Aug. 31, 1929.

Date Changed for Asphalt Paving Conference

Conflicting meetings have made it necessary to move forward the date for the Asphalt Paving Conference to be held in New Orleans, and accordingly the meeting will be held during the week of Dec. 3 instead of that of Dec. 10, as previously announced. The technical sessions will be held Dec. 4 to 7.

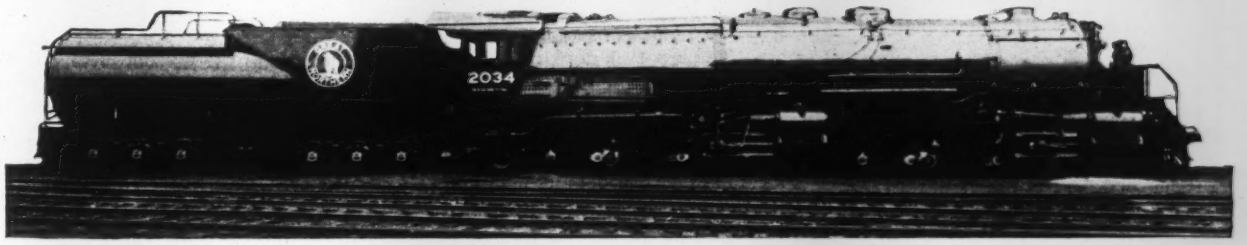
The comparatively new field of asphalt paving for airports will be thoroughly discussed by William P. McCracken, assistant Secretary of Commerce in charge of aeronautics; Col. H. H. Blee, engineer for the aeronautical division, Department of Commerce, and several others. New developments in mechanical equipment and operations involved in the construction of asphalt pavement will be presented by a number of authorities, including T. Warren Allen, of the U. S. Bureau of Public Roads; M. H. Ulman, of the Pennsylvania State Highway Department; and Prevost Hubbard, chemical engineer of the Asphalt Association. The results of service experiments in the use of asphaltic concrete in California will be presented by Chris P. Jensen, county engineer of Fresno County, California. A number of other papers are included on the program.

Cape Girardeau Bridge Opened; Others Under Construction

Dedication ceremonies for the new $1,600,000 highway bridge spanning the Mississippi River at Cape Girardeau, Mo., were held Sept. 3. The structure consists of seven through steel trusses with a total length of 3,226 ft.

Construction of the Chain of Rocks bridge at St. Louis is progressing at a rate estimated to complete the structure by the end of the year. The bridge across the Mississippi at Cairo, Ill., will be completed next February, the city officials have been advised. At Vicksburg, Miss., work on the river piers of the new highway bridge has been somewhat delayed by high water but is well under way at present.

ONE OF THE FREIGHT ENGINES BUILT BY THE GREAT NORTHERN FOR MOUNTAIN GRADES



The Great Northern Railway has built in its own shops ten articulated freight engines designed especially for heavy mountain grades. The locomotives rank in size with the largest in the country and cost approximatly $110,000 each. The long 100-car trains as now hauled across the plains can be handled over the mountain divisions by the new-type locomotives without splitting the train into shorter sections. Besides the construction of these locomotives, the Great Northern is engaged in a $4,000,000 equipment construction program, building many new freight cars of all types, as well as rebuilding many of older and nearly obsolete cars. The contemplated building program will be finished in time to enable the equipment to help handle next year's crop.

Two New Bridges in Allegheny County, Pa., Opened to Traffic

In Sept. 5 two new bridges over the Monongahela River, in Allegheny County, Pennsylvania, were officially opened to traffic. The bridges are located within 8 miles of each other, one connecting the cities of McKeesport and Duquesne, the other connecting Clairton with the borough of Glassport. The first bridge replaced an existing structure whose approach had become hazardous because of railway grade crossings. The second bridge is an entirely new crossing. Both structures were authorized in a bond issue in 1924, at which time $29,204,000 was set up for numerous road and bridge improvements.

The McKeesport-Duquesne bridge is a through-truss structure consisting of three river spans, each 382 ft. long, three approach spans on the McKeesport end totaling 653 ft., and three approach spans on the Duquesne end totaling 452 ft. The bridge has a clearance of 73 ft. above high water. The construction of the McKeesport approach required deep cuts and fills, the raising of the grade of one of the main streets, the placing of another street in a subway passage and the confining of a creek in a culvert. The main structure passes over about 60 railroad tracks. The roadway is 38 ft. between curbs. Two railway tracks have been placed on the bridge and two 11 ft. sidewalks provided for pedestrians. The estimated cost of the new bridge, including removal of the old bridge, will be approximately $2,000,000.

The Glassport-Clairton bridge is a deck cantilever structure with arched bottom chords similar to the Liberty bridge at Pittsburgh. The main bridge structure is 1,534 ft. long, consisting of three river spans totaling 900 ft. and two approach spans, each of 317 ft. At the Clairton end is a deck plate girder viaduct 678 ft. long and a reinforced-concrete ramp 350 ft. long. The 21-ft. roadway is surfaced with asphaltic concrete on a concrete base. There are two sidewalks each 8 ft. wide. The estimated cost of the structure is approximately $1,235,000.

Design and construction of both bridges was under the direction of Allegheny County Department of Public Works, Norman F. Brown, director, and Vernon R. Covell, chief engineer, bureau of bridges.

New Jersey Buys Another Delaware Toll Bridge

Purchase of the toll bridge across the Delaware River at Belvidere, N. J., has been insured by unanimous consent of the stockholders of the Belvidere-Delaware Bridge Company, who decided to accept the offer of the Interstate Bridge Commission of New Jersey and Pennsylvania of $60,000 for the structure. The bridge is of iron, 630 ft. long, and was built in 1904.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Conference on Flood-Control Act Suggested Before Congress Meets—Upper Mississippi Report Protested

BECAUSE of the feeling on the part of the local interests in the Mississippi Valley that there is some tendency to depart from the intention of Congress in carrying out the provisions of the flood-control act, a general conference, to be held before the convening of Congress, has been suggested. The idea is to devise a systematic plan under which the local interests can be active in efforts to see that the spirit of the act is carried out in the execution of the program. It is desired particularly to have a thorough understanding, before the meeting of Congress, as to the policy that will be pursued in regard to damages and flowage rights. If there is any uncertainty on the part of those charged with the administration of the law as to the exact meaning of the provisions to that end, it is felt that it should be known so that clarifying amendments may be presented at the beginning of the session, should they prove to be necessary.

Another purpose of the conference will be to insist upon the surveys between Baton Rouge and Cape Girardeau. These surveys were left to the discretion of the board of three. Its report was made, however, without having undertaken that work. In this connection members of Congress have announced their intention of asking the board for a hearing on certain phases of its report. A telegram from the President indicates that full approval of the report is being withheld.

Upper Mississippi Channel Deepening

The unfavorable report of the district engineer at Rock Island on the project of deepening the channel of the upper Mississippi from Minneapolis to the mouth of the Missouri has brought forth strong protest from civic associations of that section. The office of the Chief of Engineers has pointed out to these parties that an appeal can be made to the board of engineers for rivers and harbors. The report is now in the hands of General Jackson at St. Louis.

As the report will have to be studied further when it is dispatched to the Chief of Engineers' office, no date for the hearing can be set at this time. The project calls for a 9-ft. minimum depth in place of the present 6-ft. depth. The district engineer is opposed to deepening the channel from Minneapolis to the mouth of the Illinois, a distance of 646 miles, but approves the project from that point to the mouth of the Missouri. The principal reason given for the adverse decision on the upper section is that it is believed economically unsound.

New Jersey's Revised Traffic Law in Effect

A radical revision of many provisions in the law governing traffic in New Jersey went into effect Sept. 1, which not only moved permissible speed limits upward but corrected many other conditions which have led to highway annoyance and accident. The maximum permissible speed is now 40 m.p.h. in the open country, 20 in residential districts and business streets under regulation by signal, and 15 miles in unregulated business districts. Pedestrians are placed under the control of traffic signals, and not only forfeit their traditional right-of-way when crossing against a red light but face the possibility of arrest for disregard of signals. Soliciting rides is forbidden, as is the stopping of cars for the purpose of selling tickets, tags or other money-raising schemes. The existing "stop street" law is extended to cover all alleys and private driveways. The location of traffic signals is standardized throughout the state, but municipalities are given three years in which to change existing installations. At the end of that period all traffic signals must have been moved from the paved highway to the right-hand side of the road.

New York Suburban Transit Discussed

On Sept. 5, at the season's first regular meeting of the American Society of Civil Engineers in New York, Francis Lee Stuart discussed the suburban transit problem of the New York metropolitan district, under the title "Modernizing the Suburban Transit of the Metropolitan District." Suburban transit, as defined by Mr. Stuart, excludes all passengers carried on the subways and the municipal ferries. The principal traffic considered was that from New Jersey, where the largest losses of time are now incurred by commuters. Mr. Stuart's plan involves the connection of the various suburban sectors into a homogeneous whole and the exclusion from the business districts of Manhattan Island all through traffic between the different sections. In addition to this intercommunication between suburbs, provision would be made for a distribution system which would be supplemental to and have no physical track connections with the present city transportation system.

The engineering structures necessary for the plan include Hudson and East River crossings in the vicinity of 57th St. and at the Battery. At 57th St. a bridge crossing of the Hudson was recommended as preferable to tunnels. In Manhattan the distributing system would probably be below the local subways and would consist of two terminal tunnel routes extending from the Battery to 57th St., one on the east and one on the west side of the island.

Mr. Stuart's estimate of the cost of such a transit system was between

$1,250,000,000 and $1,500,000,000. The time set for completion of such a project was five to eight years. Although he carefully avoided specific recommendations as to how such a plan would be carried out, believing these could better be formulated by a commission set up for the purpose, he did recommend that an operating company be formed by all the railroads, this company to lease, for passenger purposes only, existing rights-of-way for such suburban railroads as would be needed.

Gustav Lindenthal, bridge engineer and promoter of a 57th St. bridge crossing of the Hudson River, spoke in support of Mr. Stuart's plan. Mr. Lindenthal believes that a fundamental feature of the scheme is the complete separation of the new system from the existing transportation systems in New York City by placing the former on a lower level. H. M. Lewis, executive engineer of the Regional Plan of New York and Its Environs, stated that Mr. Stuart's ideas in general agreed with those of the regional plan's engineers. Charles Evan Fowler, consulting engineer, believes that the plan is not practicable because of the present tendency toward decentralization of industry which, if carried to a sufficient degree, will reduce the suburban population entering Manhattan Island. Furthermore, Mr. Fowler feels that the railroads could not be persuaded to co-operate on such a scheme. As possible alternative solutions of the traffic problem he suggested abolition of street cars and the substitution of buses, and, perhaps, the inauguration of one-way streets north and south in Manhattan. John A. Miller, associate editor, *Electric Railway Journal*, took an entirely different viewpoint from Mr. Stuart, maintaining that present ferry service, if improved and increased, will more rapidly and economically transport New Jersey commuters to the respective sections of Manhattan which they want to reach.

Personal Notes

Col. C. W. KUTZ, of the Corps of Engineers, has assumed the duties of the department engineer of the Hawaiian Department. He will be stationed at Fort Shafter, near Honolulu.

FORD KURTZ has been appointed hydraulic engineer, in charge of the hydraulic division of the J. G. White Engineering Corporation, New York City. Mr. Kurtz, who is a graduate of Cornell University, has been a member of the engineering staff of that company on both field and office assignments since 1910 and for the past six years has been in immediate charge of all hydraulic design work.

Lieut.-Col. J. FRANKLYN BELL has taken over the duties of the office of district engineer of the Pacific Division. This will be in addition to his present duties as engineer of the Ninth Corps area at San Francisco.

Engineering Societies

CALENDAR

Annual Meetings

INTERNATIONAL CITY MANAGERS ASSOCIATION, Lawrence, Kan.; annual convention, Asheville, N. C., Sept. 17-20.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; annual convention, Montreal, Canada, Sept. 18-21.

NATIONAL SAFETY COUNCIL, Chicago; annual meeting, New York City, Oct. 1-5.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; fall meeting, San Diego, Calif., Oct. 3-5.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; annual convention, Toronto, Canada, Oct. 8-9.

SOUTHWEST WATER WORKS ASSOCIATION, Fort Worth, Tex.; annual convention, Dallas, Tex., Oct. 15-18.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York, N. Y.; annual convention, Chicago, Ill., Oct. 15-19.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; annual convention, Detroit, Mich., Oct. 22-28.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION, Chicago, Ill.; annual convention, Boston, Mass., Oct. 23-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York, N. Y.; annual convention, Biloxi-Gulfport, Miss., Nov. 13-17.

THE NATIONAL SAFETY COUNCIL, Construction Section, will hear a number of papers at the National Safety Congress to be held in New York City Oct. 1-5. Talks will be given by R. H. Shreve, president, New York Building Congress; John Sullivan, president, New York State Federation of Labor; and James A. Hamilton, industrial commissioner, New York State Department of Labor. Papers will be presented as follows: "Safety by New York Contractors," by H. W. Lohmann, chairman, committee of accident prevention, Building Trades Employers Association of New York City; "Educating for Safety on the Job," by F. H. Westmeyer, A. Bentley & Sons Company, Toledo, Ohio; "Safety and the State," by C. A. Walters, secretary, Department of Labor and Industry, Harrisburg, Pa.; "Safety in Power Plant Work," by Frank E. Cudworth, resident engineer, Hudson River bridge; "Safety in Steel Erection," by R. B. Thomas, Structural Steel Board of Trade, New York City; and "Wire Rope and Safety," by D. F. McMurchy, structural engineer, Industrial Commission of Ohio.

THE AMERICAN ROAD BUILDERS ASSOCIATION is planning a trip to Mexico City to attend the Mexican Highway Congress. The executive committee of the association, together with a number of members and representatives of American manufacturers, will leave Washington Sept. 25. The party already numbers 80, and it is expected that more will make the trip. Arrangements are in charge of Charles Upham, secretary-director of the American Road Builders Association, Washington, D. C.

THE AMERICAN CONCRETE INSTITUTE board of direction will hold its fall meeting at Buck Hill Falls, Pa., Oct. 6, by invitation of Past-President Henry C. Turner.

Obituary

DAVID J. HOWELL, senior member of the engineering firm of David J. Howell & Son, Washington, D. C., died suddenly of heart failure on Aug. 28 while engaged in inspection of construction work. Mr. Howell was born in West Virginia 65 years ago and was graduated from Washington and Lee University. Most of his professional life was devoted to private practice, which embraced a variety of important projects, such as layout of and improvements to water-works and sewage-works in New York, Virginia, Maryland and Washington, D. C. He was a member of the American Society of Civil Engineers, the New England Water Works Association, the American Water Works Association and the Washington Society of Civil Engineers.

JOHN B. MCATEER, of Pittsburgh, who for 22 years before his retirement two years ago was employed in the bureau of water of that city and at the time of his retirement was assistant chief engineer, died on Sept. 5. He was 65 years old.

G. N. BLAIS, an engineer in the Quebec provincial department of roads, and LOMER FUGERE, superintendent of roads at La Chute, Que., were killed on Sept. 6 when the automobile in which they were riding collided with a Canadian Pacific Railway train near La Chute. Mr. Fugere, when he saw a collision was inevitable, threw his seven-year-old son from the car, and the lad escaped unhurt.

CAREY ALLEN TUSCH, retired irrigation and reclamation engineer, died recently at his home in Oakland, Calif., at the age of 65. Before his retirement from active work eight years ago, Mr. Tusch had been connected with some of the large irrigation and dam projects in the West. He is credited with the discovery of the site for the American Falls reservoir in Idaho, and was chief engineer of the Twin Falls project for some time. In California, he was connected with the Boston Land Company in Tulare Valley, where 50,000 acres were watered from wells.

GEORGE P. OLCOTT died Sept. 1 at his home in East Orange, N. J., at the age of 78. He had maintained an engineering office in East Orange for many years until his retirement from active practice a few years ago.

WALTER T. SPENCER, superintendent of the Boston division of the New York, New Haven & Hartford Railroad, died recently in Boston, Mass. Mr. Spencer was a native of Guilford, Conn., and had been connected with the New Haven road since his graduation from Sheffield scientific school, Yale University, in 1890. He was a member of the American Society of Civil Engineers and of the Connecticut Society of Civil Engineers.

Construction Equipment and Materials

Many Exhibitors at New England Water-Works Convention

All of the exhibit space available at the convention of the New England Water Works Association has been taken. The convention will be held in Montreal, Canada, Sept. 18-21 at the Windsor Hotel. The complete list of exhibitors follows:

Pittsburgh Equitable Meter Company.
Thomson Meter Corporation.
Neptune Meter Company.
Water Works Engineering.
The American City.
Pittsburgh-Des Moines Steel Company.
Engineering News-Record.
Ross Valve Manufacturing Company, Inc.
R. D. Wood & Company.
Lead Lined Iron Pipe Company.
The Pitometer Company.
United States Cast Iron Pipe & Foundry Company.
Kennedy Valve Manufacturing Company.
National Tube Company.
Hersey Manufacturing Company.
Builders Iron Foundry.
The Canadian Engineer.
George A. Caldwell Company.
Federal Meter Corporation.
A. P. Smith Manufacturing Company.
Paradon Manufacturing Company.
Union Water Meter Company.
W. & L. E. Gurley.
National Meter Company.
Red Hed Manufacturing Company.
McWane Cast Iron Pipe Company.
Wallace & Tiernan Company, Inc.
Public Works.
The Central Foundry Company.
Worthington Pump & Machinery Corporation.
Rensselaer Valve Company.
Hydraulic Development Company.
Edson Manufacturing Company.
Badger Meter Manufacturing Company.
Gillette Publishing Company.
Gamon Meter Company.
Buffalo Meter Company.
Mueller Company.
Lock Joint Pipe Company.
Eddy Valve Company.
Cement Lined Pipe Company.
Phoenix Meter Company.
Norwood Engineering Company.
Leadite Company.
Simplex Valve & Meter Company.
Bingham & Taylor Corporation.
Iowa Valve Company.

Business Notes

RANSOME CONCRETE MACHINERY COMPANY, Dunellen, N. J., has appointed the Western Contractors Supply Company, 14 North Clinton St., Chicago, as its distributor in the Chicago territory. The new distributor will not only carry a complete line of Ransome equipment but has taken over the Ransome factory-trained service organization which has been in existence in Chicago.

NATIONAL LUMBER MANUFACTURERS ASSOCIATION announces that the thirteenth of a series of offices has just been established at Pittsburgh. The purpose of the new office is to bring to lumber users in the Pittsburgh territory the benefits of the association's technical staff's assistance in its trade promotional campaign for the wider use of standard lumber. Harold S. Crosby, until recently attached to the New York office of the association, has taken charge of the Pittsburgh territory.

THE PLASTICO SEWER PIPE JOINT COMPANY, Valley Junction, Iowa, announces the appointment of C. W. Sullivan as manager of its Chicago office, which conducts the business of the firm in Illinois, Wisconsin, Michigan, Indiana and Ohio. Mr. Sullivan was formerly with the sales department of the What-Cheer Clay Products Company.

THE CHARLES T. TOPPING MACHINERY COMPANY, manufacturer of excavating machinery, has moved its offices from Dayton, Ohio, to Cleveland, Ohio. The new facilities will give the company enlarged manufacturing space and consequently larger production.

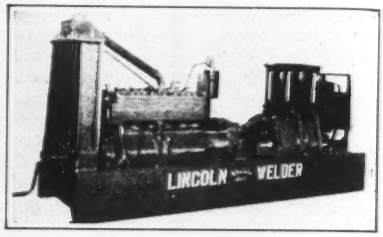
THE PREST-O-LITE COMPANY, INC., New York City, has lately added two new plants to its nation-wide chain, making the total 33. These new plants will serve near-by industries with dissolved acetylene, used in oxy-acetylene welding and cutting. The plants are located in Harrisburg, Pa., and Allentown, Pa.

JOSEPH ANDREW JEFFREY, chairman of the board of directors and founder of the Jeffrey Manufacturing Company, Columbus, Ohio, died at his home Aug. 27, at the age of 92 years. Starting his business life as a banker, Mr. Jeffrey entered the industrial field in 1883 by acquiring a controlling interest in the Lechner Machine Company, Columbus, Ohio. The name of the company was later changed to the Lechner Mining Machine Company, still later to the Lechner Manufacturing Company and finally to the Jeffrey Manufacturing Company. Mr. Jeffrey retired from the presidency in 1900 to become chairman of the board of directors.

New Developments

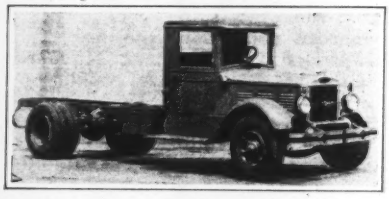
New 300-Amp. Arc Welder

A welding generator rated at 300 amp. with a current range from 75 to 400 amp. direct-connected to a six-cylinder Buda Model HS-6 engine, operating at 1,500 r.p.m., has been developed by the Lincoln Electric Company, Cleveland, Ohio. The unit is mounted on a welded steel base. The engine has an S.A.E. rating of 27.3 hp. and gives a brake horsepower of 41 while running at the operating speed. The generator has the laminated magnetic circuit with separately excited field, stabilizer, variable voltage and other features characteristic of the company's line of "Stable-Arc" welders. The over-all dimensions are 93 in. long, 35 in. wide and 45 in. high. The equipment has been designed to meet the increasing use of larger electrode in welding work.



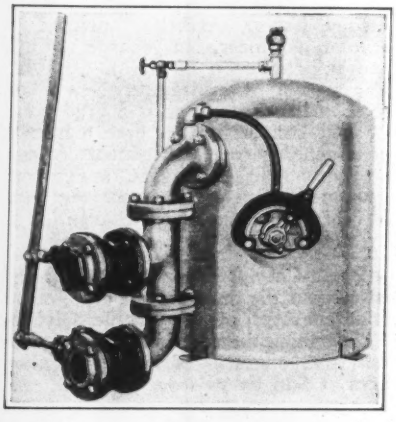
A New Six-Cylinder Truck of 3 to 4 Tons Capacity

A special highway truck recommended to those requiring a fast vehicle having ample road clearance is announced by Mack Trucks, Inc., New York City. It is a six-cylinder truck, model BJ, of 3 to 4 tons capacity. Being developed for a specific field of haulage, it is not recommended for dump-truck work. Wheelbases of 168½, 192½ and 218 in. are provided. Springs are semi-elliptic all around and mounted on top of the axle. Rubber shock insulators connect all eight spring tips with the frame, which is heat-treated pressed steel. An inclosed cab is standard equipment with the truck. The body space on the frame back of the cab is 12x16 ft.



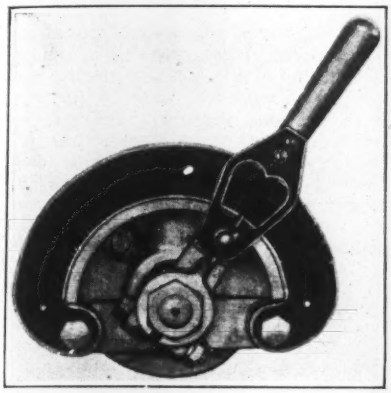
Sand Moisture Correction Made by New Water-Measuring Tank

The new water-measuring tank for concrete mixer installation which has been developed by the Lakewood Engineering Company, Cleveland, is an accurate measuring device containing in its



design a provision for quick allowance of the moisture contained in the aggregates of the mix.

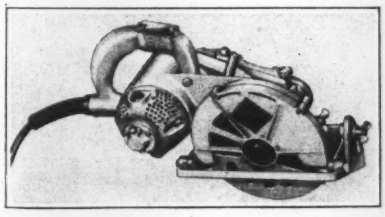
The tank works on the siphon principle, and the adjustment of capacity is made by raising or lowering an air pipe within the tank. In operation, as the water flows out and its level reaches the siphon pipe the siphonic action is broken and the discharge stopped. The accompanying illustrations show the tank together with the control lever and quadrant. It will be noted that the upper part of the scale is in gallons, and the lower scale is in pounds. A double



pointer is provided on the lever so that a given setting of the tank can be read simultaneously in gallons and pounds. For example, for a mix requiring 48 gal. of water and a compensation for 40 lb. of moisture in the sand, the lever would be set at 48 on the upper scale and then moved back to 40 lb. on the lower scale to 360 lb., as shown in the accompanying illustration. Thus the correct amount of water is automatically added to the mix. These new water-regulating tanks are available in 18-gal. sizes for the 7-S and 10-S mixers, in 24-gal. size for the 14-S mixer, 36-gal. size for the 21-S mixer, in 48-gal. size for the 28-S mixer and in the 96-gal. size for the 56-S mixer.

Power Handsaw for Light Work

A new small electric handsaw, cutting capacity 2 in., equipped with a safety guard, has been added to the line of Alta portable electric tools by the Wappat Gear Works, Inc., Pittsburgh, Pa. The saw blade is completely guarded, the lower guard gradually opening as the saw is pushed into the material. When the cut is finished it immediately snaps shut, affording protection to both operator and saw blade. The blade is driven by a high-speed universal motor, fan cooled, which is mounted on ball



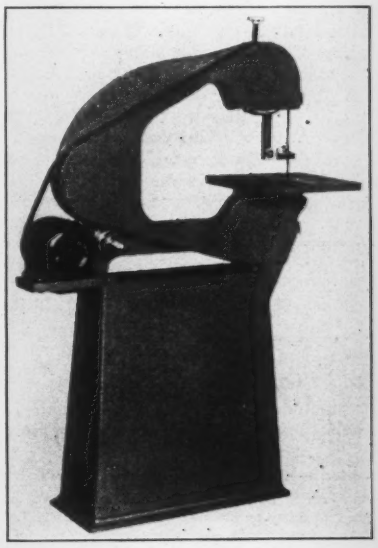
bearings. An air blast directed to the front of the saw clears the sawdust away and makes it possible to follow a line accurately. The saw shaft is driven by helical gears, mounted on roller bearings and running in grease. The switch is mounted in the handle within easy reach of the operator's forefinger. Lightness is secured by the use of an all-aluminum frame, highly polished. Steel parts are rustproofed where exposed. The saw is built in three models, for plain square cutting, for bevel cutting and for grooving. In all three models the shoe is adjustable vertically, making it possible to set the saw to cut any required depth.

Now Rolling 36-In. Wide-Flange Beams and Girders

The rolling of a series of 36-in. wide-flange beams and girders in commercial production has been announced by the Bethlehem Steel Company. These are being produced at the Lackawanna plant, Lackawanna, N. Y. The 36-in. I-beams are rolled in weights of 147, 155, 164 and 173 lb. per foot. Girder beams are rolled in weights of 231, 240, 250 and 260 lb. per foot. It is only a short time since the Bethlehem Company first began the production of 33-in. beams and girders.

Portable Band Saw for Contractor's Use

A new band saw, designed to provide in a portable machine the power and handling capacity of a stationary band saw, has been developed by the DeWalt



Products Company, Leola, Pa. The machine, as shown in the accompanying illustration, is guarded to a maximum degree. The saw above the floor standard is mounted in one casting housing. The unusual feature of using three tracking pulleys instead of two large pulleys to separate the two sections of a revolving saw blade makes it possible to design a compact machine with 20 in. clearance in the throat between the saw blade and frame. This gives the machine a capacity to handle material up to 7 in. thick. The entire machine, including floor standard and motor, weighs 210 lb. Only 8 in. of the saw surface is exposed and that only at the cutting point. The working table is 13⅜ in. square and tilts 45 deg. to the right and 30 deg. to the left. The usual motor is a ½-hp. unit.

Fighting Fires With Carbon Dioxide

The use of carbon dioxide gas as a fire-extinguishing medium operates under the principle of displacing the oxygen necessary to support combustion with the carbon dioxide, which is 50 per cent heavier than air. A portable type of fire extinguisher using carbon dioxide has been developed by the Fyre-Freez Corporation, New York City. The extinguisher is in the form of a steel cylinder fitted with a short piece of metallic flexible hose having a funnel-shaped nozzle. The cylinders are filled with liquefied carbon dioxide gas under pressure of about 800 lb. per square inch. The extinguisher is operated by turning a hand valve, which releases the gas into the atmosphere, at the same time solidifying it to dry carbonic snow at a temperature of 110 deg. below zero. The sublimation of the snow back to gas absorbs the heat in great quantities and the gas displaces the oxygen.

On Aug. 16 at a conference of the U. S. Steamboat Inspection Service a number of tests were carried out at the plant of the General Carbonic Company in Long Island City to determine the merits of carbon dioxide gas as an extinguishing medium. According to reports of the company, the carbon dioxide extinguished fires in oil spread over floors and fires occurring in confined places such as engine rooms in motor boats, etc. The tests also demonstrated that carbon dioxide is capable of extinguishing fires in troublesome liquids, such as alcohol, lacquer, naphtha, benzine or gasoline. Neither the gas nor the carbon dioxide snow is a conductor of electricity, which is an advantage over water in fires around electrical machinery or equipment. Finally, the results of the tests show that the carbon dioxide gas leaves no mark or discoloration on the material which it covers.

Manufacturers and Trade Associations

CALENDAR

ANNUAL MEETINGS

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; semi-annual meeting, Buckwood Inn, Shawnee-on-Delaware, Pa., October 1-3, 1928.

The Business Side of Construction

General Construction Industry Reports Its 1927 Profits

Data are now available by which to compare the earnings of American corporations for the past three years. The Standard Statistics Company, of New York, has made a study of the statements of 650 large industrial and utility concerns and finds some trends which are of great interest to American industry as a whole.

This bureau finds that 1927 business profits registered a substantial decline as compared with those of the year preceding, the decrease for 650 corporations being 16.2 per cent. The reasons given for this decline in net profits during 1927 are given by the Standard Statistics Company as four in number: the total volume of industrial output was smaller than in 1928; the trend of commodity prices was mainly downward; the margin of profits was smaller; and unsatisfactory and even acute conditions prevailed in some of the primary industries.

It must be remembered, however, that this rather large drop in the net profits was from an abnormally high level, and it is generally conceded that in spite of this drop under 1926, the 1927 profits were in general satisfactory to the investor. Only a few industrial concerns were unable to meet their regular dividend charges. Under such conditions, a drop in earnings assumes considerably less importance than it would assume at times when a decline of, say, 12 per cent, might easily have created a situation of real distress.

Profits in the Construction Industry

The accompanying table gives a portion of the financial data of corporations operating in the general construction industry. The data are not sufficiently complete to depict accurately conditions in the industry as a whole, but unit and group comparisons are possible. It appears that the 1927 profits of most of the companies interested in construction operations were less than those of 1926. The income before the deduction of fixed charges of 25 building equipment, supplies and construction corporations with an invested capital of $719,827,000 was $67,847,000 in 1927, as against $77,091,000 in 1926, a reduction of almost $10,000,000. The present rate of dividends paid to the common stockholders of this group is 5.7 per cent, although a number of the companies are quoted at an 8 per cent return to the stockholders. The corporations turning out asphalt and cement report a much higher yield —7.4 per cent—one of these corporations returning 13.3 per cent to the stockholders. That the corporations interested in general construction are faring in general better than American industrials as a whole is indicated by the fact that the average return to the common stockholders of 386 American industrials at present is only 5.2 per cent.

While the past year is interesting in determining trends, the profits during the current year are of special interest just at present. The outlook in the general construction industry for the year 1928 as a whole is excellent. Prices and wages have remained about on a level with 1927, while the volume of operations as indicated by the value of contracts let during the first eight months of the year was about 17 per cent above that of the same period last year. The year 1928 should prove easily a record year for the construction industry from a net earnings standpoint.

E. N.-R. Index Numbers

Cost		Volume	
Sept. 1, 1928	**207.29**	**August, 1928**	**306**
Aug. 1, 1928	207.29	July, 1928	266
Sept. 1, 1927	203.60	August, 1927	306
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913.....	100.00	1913.....	100

EARNINGS OF CORPORATIONS IN BUILDING, REAL ESTATE AND RELATED LINES
1925, 1926 AND 1927
(As collected by the Standard Statistics Company of New York)

Name of Company	Total Invested Capital $1,000	Income Before Fixed Charges 1925 $1,000	1926 $1,000	1927 $1,000	Earnings on Common Stock (Dollars Per Share) 1925	1926	1927	Present Yield %
Asphalt and Cement:								
Alpha Portland Cement Co.	26,759	3,858	2,603	2,359	6.19	4.16	3.74	6.7
General Asphalt Co.	43,685	1,819	2,302	1,619	5.79	8.12	4.74	...
International Cement Corp.	37,712	3,976	4,355	4,554	(b) 6.63	(b) 6.16	(b) 6.54	6.3
Total for five companies	119,792	10,502	10,375	10,344	.....	.....	.....	7.4
Equipment, Supplies and Construction								
American Radiator Co.	89,426	11,807	12,673	12,217	8.97	9.66	8.53	3.4
Bucyrus-Erie Co.	23,848	.....	.....	.....	(c) 3.54	(c) 3.63	(c) 3.35	2.9
Certain-teed Products Corp.	40,867	2,101	2,335	2,340	(b) 4.52	(b) 5.26	(b) 5.31	9.1
Great Lakes Dredge & Dock	11,566	1,527	1,162	2,586	22.13	16.84	37.46	3.3
Johns-Manville Corp.	32,016	2,426	3,778	4,108	3.23	4.34	4.78	2.4
Long-Bell Lumber	100,999	4,812	2,718	(d) 617	(a) 8.10	(a) 4.58	(ad) 1.04	...
Otis Elevator Co.	36,749	4,750	5,052	5,649	10.25	10.87	12.16	3.4
Pittsburgh Plate Glass Co.	82,475	12,123	10,017	6,430	24.61	20.36	13.06	3.1
Sherwin-Williams Co.	37,827	4,482	4,262	4,728	5.88	5.59	6.42	4.4
Standard Sanitary Mfg. Co.	49,690	9,203	7,736	7,795	2.78	2.29	3.31	...
U. S. Gypsum Co.	46,199	8,414	8,376	7,539	11.44	11.35	10.08	2.9
Walworth Co.	26,702	1,227	1,377	1,124	2.08	1.61	1.01	8.0
Total 25 companies	719,827	78,291	77,091	67,847	.....	.....	.....	5.7

(a) Not allowing for participating features of other issues. (b) After preferred stock sinking fund. (c) Earnings predecessor companies. (d) Deficit.

High General Industrial Operations Continue

Consumption of electrical energy by 3,600 manufacturing plants as collected by *Electrical World* indicates that the summer season closed with the rate of general industrial production on an unusually high plane for this season of the year. The August rate of operations was about 1 per cent under July but was 7.6 per cent over the rate of operations during August last year. American industry as a whole has been operating on an unusually high plane ever since last March, and during this five-month period the rate of activity has not varied by more than 4 per cent, while during 1927 the productive activity during this same period varied by over 10 per cent. There has been practically no so-called "business slump" in general industry during the current year, but on the contrary in several industrial groups the summer operations have exceeded those of the early spring months, an unusual condition in these industrial groups.

New Construction 10 Per Cent Over Last Year

The week ended Sept. 6 witnessed a volume of new construction, as indicated by the value of contracts let, some 9 per cent above that of the week previous and almost 10 per cent above the same week last year, the current figures being $65,607,000 as against $60,019,000 last year. While this gain over last year is not as large as reported for several weeks previous, yet it is sufficient to indicate that the closing months of the current year will witness a high rate of building and engineering construction.

A substantial increase over last year was witnessed in the value of contracts let for both buildings and roads. Of the total figures for the week, 51 per cent was for private construction projects and 49 for public works of various kinds.

Lumber Shipments at New High

Record shipments featured the lumber movement for the week ended Sept. 1, according to the National Lumber Manufacturers Association. Total shipments reached 409,960,000 ft., and production amounted to 362,046,000 ft., varying slightly from the week before, while orders showed an appreciable increase.

August Contracts

Heavy construction contracts, reported by *Engineering News-Record* in August, 1927 and 1928, total as follows:

(In Thousands of Dollars, 000 Omitted)

	Buildings	Other	Total
August, 1928	$222,701	$144,862	$367,563
August, 1927	173,631	115,713	289,344
Eight months:			
1928.....	1,519,694	877,920	2,397,614
1927.....	1,221,288	823,685	2,044,973